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Full Credit Should Be Given

ANYONE who has read the bulletin containing the report of the Committee on Stresses in Track cannot but be impressed with the enormous volume of work which had to be carried on in the preparation of the material on which this report is based. But what is also definitely apparent is that such a study would be utterly impossible if some organization or organizations did not supply the funds necessary to defray the expenses incurred in any investigation carried out on such a large scale. This relates not only to the outlay made by the railroads in providing the facilities and equipment and in putting up with the inconvenience and interference with traffic entailed in the use of their tracks for test purposes but also to the funds donated by various industrial corporations for furthering this work. Donations of this kind offer no immediate return that can be translated in dollars and cents to the particular corporations which supplied the funds. The benefits which it has anticipated will accrue from this work are such as may be realized purely from a more thorough understanding of facts relating to the behavior of track under the action of various kinds of equipment. Ultimately this added knowledge will result in improvements and economies in design of unquestioned value but these advantages will be available to all who are concerned in any way with the problems presented. While it is true that those responsible for the donations of funds for these tests expect to derive some measure of return for the money invested, the hope of return is obviously so direct that their action must be ascribed primarily to altruism. The engineering profession owes a distinct debt to those who have helped to make these investigations possible.

Better Planning Called For

READERS of the report of the Committee on Signs, Fences and Crossings were placed in a rather confused state of mind upon reading Appendices D and E, both of which carried the caption "Elimination of Highway Grade Crossings." While the reports appearing under the two appendices clearly indicated that the subcommittees assigned to their preparation were instructed to cover this subject from different angles, there is an unfortunate overlap in the matter presented in the two reports since in each case considerable space is devoted to a number of the general considerations involved in the study of this subject. This is a striking illustration of the necessity for the careful review of sub-committee reports before they are combined to form the report of the entire committee. The committee reports of the American Railway Engineering Association, even with the greatest care in editing, necessarily covered a large number of printed pages but since the value of the committee work is measured largely by the extent to which the reports are read by members and others engaged in railway engineering, every effort should be made to present the reports in as concise a form as possible.

Is Permanent Roadway Justified?

"*I AM* confident that the money invested in permanent roadbed will effect a saving in labor from the start that will more than take care of interest and depreciation on the investment." In this statement Frank H. Alfred, president of the Pere Marquette, expressed his conviction at the annual dinner last evening that railway engineers owe it to their managements to give more attention to the strengthening of their track structure in order that maintenance expenses may be reduced. It is capable of ready demonstration that the railways as a whole can earn an adequate return on large investment for the strengthening of the track structure in the form of reduced expenditures for maintenance. It is recognized, of course, that the traffic on many branch lines is not sufficiently heavy to warrant other than the minimum expenditure, but on the other hand, there is also a large mileage on which the traffic is of such density as to warrant the use of heavier rail, more and better ballast, better drainage, wider embankments, more permanent bridges and other improvements of a similar character. The problem of determining the amount which a road

can afford to spend for a more permanent form of construction in order to reduce its upkeep expenditures requires careful consideration and the exercise of judgment of the highest order, for it is entirely possible for a road to spend an entirely unwarranted amount. However, as conditions exist at present this is a remote possibility for there are few if any railways whose expenditures for permanent construction on busy lines even approach the amount on which a reasonable return can be earned. Members of the American Railway Engineering Association and other engineering and executive officers can well afford to give this phase of their work careful consideration.

The Problem of the Tie Plate

THE work of the Committee on Stresses in Track, as presented in its latest progress report, has gone a long way towards settling the controversy regarding the canting of rail. It also opens up an avenue for the further study of tie plates. One of the points brought out in the report is that rail supported on a beveled tie plate is not actually canted to the exact angle determined by the bevel of the plate. The angle of cant on curved track is actually less than that determined by the bevel of the plate while on tangent track it is greater. This variation from the desired cant results from an unequal distribution of the pressure of the tie plate on the tie. In other words, the tie plate compresses the fibers of the wood to a greater extent on the inside of the rail on tangent and on the outside of the rail on curves. This condition is brought about by the fact that it is practically impossible with even the larger sizes of plates now in use to avoid excessive eccentricity of pressure on ties under all conditions of loading. In view of this it would seem that an ideal arrangement would be to provide three designs of tie plates, each with the requisite eccentricity to meet the conditions to be encountered on tangent track, light curves and heavy curves, respectively. This arrangement, however, could not readily be applied on a practical basis and it is entirely possible that the same result could be accomplished by using tie plates appreciably larger than those now generally used in order that the average pressure on the top of the tie would be reduced to such an extent that the effect of eccentric loading would be minimized.

Any design of plate which will decrease the bearing pressure on the ties would afford insurance against their premature mechanical destruction, which is still a problem of primary importance, as indicated by the discussion following the presentation of the Wood Preservation Committee's report. Large tie plates would also afford greater assurance that rail would be held at the exact cant provided for in the design of the tie plate.

Now there is obviously some point of balance between the advantages to be gained by larger tie plates and the cost of the additional metal in the plate. This added cost would probably be justified without difficulty if it would be possible to insure a reasonable life of the plate. Considerable progress in this direction has been obtained by adopting measures which will tend to overcome the destructive tendencies of corrosion.

There is no economy in installing extra large plates under rail of a given weight if these tie plates must be removed within a few years because of the necessity for increasing the rail section. Those railroads which have already adopted a section of rail of sufficient weight to insure its adequacy for anticipated increases in traffic can, in all probability, afford definite economies by the adoption of heavier designs of tie plates.

E. O. Faulkner, manager of the tie and timber department of the Atchison, Topeka & Santa Fe, Los Angeles, Cal., visited the convention for the first time in several years. Mr. Faulkner will be recalled as the man who was largely responsible for the development of the use of creosoted timber on the Santa Fe 20 years ago. He is now a resident of southern California, where he is in charge of the oil properties of the Santa Fe.

Annual Meeting of Signal Appliance Association

The Signal Appliance Association held its annual meeting yesterday morning at 11 o'clock at the Drake Hotel. M. J. Fox, signal engineer of the Railroad Supply Company, was elected chairman for the ensuing year; W. P. Allen, Union Switch & Signal Company, was elected vice chairman and Frank W. Edmunds, Sunbeam Electric Company, was elected secretary-treasurer. New members elected were W. J. Gillingham, vice president, Hall Switch & Signal Co.; W. M. Manuel, Corning Glass Co.; J. J. Hubbard, General Railway Signal Co., and A. E. Pratt, manager, railway sales division, National Carbon Co.

Friday's Program for Signal Section

The second day's session of the convention of the Signal section of the American Railway Association will open in the ballroom of the Drake hotel at 9:30 this morning.

J. J. Kennedy, electrical engineer of the Pyle National Company will present a paper on Turbo-Generators for Automatic Train Control.

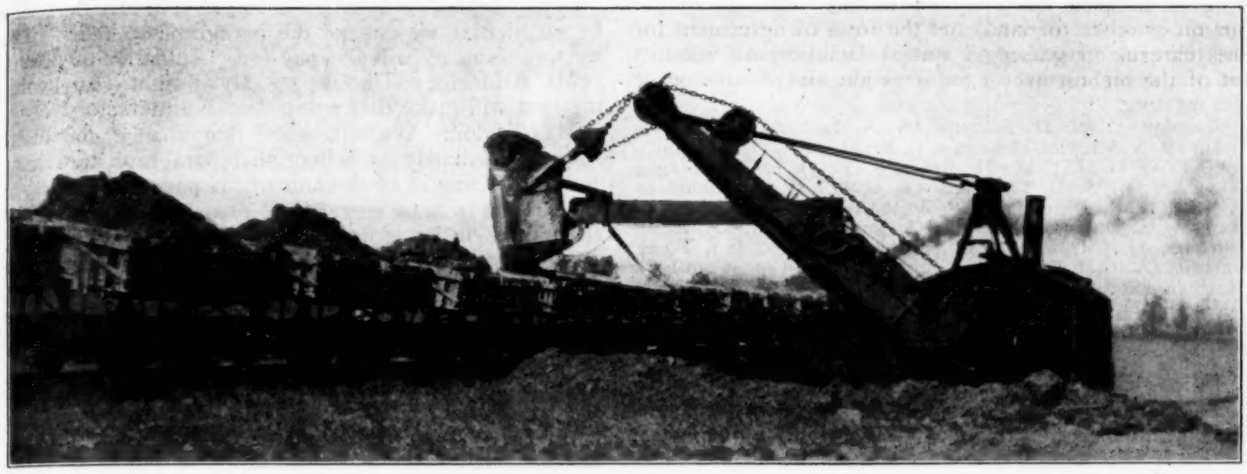
The report of Committee I—Economics of Signaling will include the presentation of 17 papers on the movement of trains by signal indication to be presented by: W. Y. Scott, B. & M.; M. A. Baird, Erie; W. M. Post, Penn.; H. G. Morgan, I. C.; J. E. Saunders, D., L. & W.; B. J. Schwendt, N. Y. C.; H. S. Balliet, N. Y. C.; B. T. Anderson, C. & O.; Geo. S. Pflasterer, N., C. & St. L.; S. N. Wight, General Railway Signal Co.; H. W. Griffin, Union Switch & Signal Co.; Col. Azel Ames, Kerite Insulated Wire & Cable Co.; G. M. Basford, G. M. Basford Co.; E. B. DeMeritt, C. of Ga.; W. F. Follett, N. Y., N. H. & H.; J. B. Latimer, C., B. & Q., and E. Hanson, G., C. & S. Fe.

Unfinished Business.

New Business.

Election of Officers.

Adjournment.



Steam Shovel Work for the Michigan Central's New Yard at Toledo, Ohio

A.R.E.A. Convention Comes to a Close

Last two sessions which occupied entire day were well attended—new officers installed

AS IN OTHER recent years, the last day of the American Railway Engineering Association was an exceedingly busy one, the amount of work being such as to require two full sessions. That the interest in the reports and discussions did not flag was evidenced by a full attendance until the falling of the president's gavel at five o'clock brought the twenty-sixth annual convention to a close. As indicated in another coumn, the total registration for the three days is almost exactly equal to that of last year.

Reports were presented by the Committee on Uniform General Contract Forms; Wooden Bridges and Trestles; Track; Signs, Fences and Crossings; Rail; Records and Accounts; Economics of Railway Labor; Ties Standardization, and Yards and Terminals. This schedule, involved one change from the regular program in that the Committees covering Co-operative Relations with Universities, and Yards and Terminals exchanged places on the program, the last named presenting its report on Wednesday instead of Thursday. Following the presentation of the last committee report the officers for the ensuing year were installed.

Report on Uniform General Contract Forms

The Committee on Uniform General Contract Forms submitted for adoption a form of option for the purchase of land and a form of agreement for the joint use of passenger station facilities. It presented for information and discussion forms of agreement for the purchase of electrical energy, for the joint use of freight station facilities, for joint pole lines and for furnishing water from railway water systems to employees and others. The committee also considered the result of the report of the Joint Conference on Standard Construction Contracts, to which the chairman was a delegate, and J. C. Irwin an alternate. W. D. Faucette has been chairman of the Committee on Uniform General Contract Forms for a period of five years and a member of it for the last 9 years.

W. D. Faucette
Chairman

THE COMMITEE presented a report covering a form of agreement for furnishing water from railway water systems to employes or others (Appendix A), a form of agreement for the joint use of passenger station facilities, as well as one for the joint use of freight station facilities (Appendix B); a form of option for the purchase of land, and a form of agreement for joint pole line (Appendix C). It also submitted, without change, a form of agreement for the purchase of electrical energy, as presented in 1924.

It recommended the adoption of the form of option for the purchase of land, and the form of agreement for the joint use of passenger station facilities, and submitted the other forms for information and discussion at the meeting.

Committee: W. D. Facuette (S. A. L.), chairman; J. C. Irwin (B. & A.), vice-chairman; C. Frank Allen (Con. Engr.), J. S. Lillie (G. T.), W. H. Brameld (Erie), O. K. Morgan (C. C. & O.), J. B. Carothers (B. & O.), F. L. Nicholson (N. S.), Clark Dillenbeck (P. & R.), C. B. Niehaus (C. of Ga.), W. A. Duff (C. N. R.), H. A. Palmer (C. N. R.), E. M. Durham, Jr. (M. P.), A. C. Shields (D. & R. G.), F. H. Fechtig (A. C. L.), Charles Silliman (Pres. Con. Com.), B. Herman (Sou.), E. L. Taylor (N. Y. N. H. & H.), F. R. Judd (I. C.), C. A. Wilson (Con. Engr.), John Worley (U. of Mich.).

Discussion

[Vice-chairman, J. C. Irwin, presented the report, in the absence of its chairman, W. D. Faucette. The report in Appendix A, a form of agreement for the joint use of passenger facilities, was submitted by Clerk Dillenbeck, chairman of the sub-committe. *It was moved and carried that this form be accepted and printed in the Manual.*]

C. W. Baldridge (A. T. & S. F.): In this proposed form of option for the purchase of land, provision is made for a lump sum of money "payable as follows." It probably is the intent of this committee to leave the necessary blank lines after that statement for writing in the terms of payment.

It should also be made clear whether the payment for examination of titles and such matters is to be paid by the railway company outside of the agreed lump sum.

E. L. Taylor (N. Y. N. H. & H.): Will Mr. Baldridge be satisfied if we change the paragraph to read: "The railway company will also pay for examination of titles?"

Mr. Baldridge: That is perfectly all right. Any wording that will make that point clear is satisfactory.

Mr. Taylor: We will make that change and insert space immediately preceding that paragraph, providing for the writing in of the amount of payment.

(Subject to those corrections *it was moved and carried that the form be adopted for inclusion in the Manual.*)

D. J. Brumley: Referring to the form of agreement for the purchase of electrical energy, I assume that this proposed agreement is intended to cover the purchase of small quantities of electrical energy, probably such as railroads use in miscellaneous light and power around terminals. If it is proposed to use this form of contract for the purchase of electric energy for track purposes, it might be amplified to take care of the growth of the railroad companies' business on either the purchase of miscellaneous light and power or of curve tracks.

I would like to suggest to the committee that with reference to the determination of base price of fuel, it consider the use of a power ratio, or heat ratio, which would take into consideration the heat content per pound of coal or per unit of oil. There are a great many varieties of coal used in the generation of electrical energy. The coals on the Atlantic sea coast have a greater heat unit than those in the Mississippi valley, so the price of coal is not the only important factor.

(The Committee was dismissed with the thanks of the Association.)

Report of Committee on Yards and Terminals

The Committee on Yards and Terminals presented reports in the last two years which included detailed studies of the relation between passenger station facilities and the business handled. This year the committee has carried this study forward and presented a detailed analysis of the problem from the standpoint of commuter traffic as contrasted with that of through traffic. In addition the committee has submitted a detailed and thorough report on the handling of freight, dealing particularly with the economics of various types of freight houses and involving both operating and investment charges. Data on the arrangement of terminals to produce economies in operation were also presented. J. R. W. Ambrose, the new chairman, has been a member of this committee for 3 years.

J. R. W. Ambrose
Chairman

THE COMMITTEE submitted reports on the following subjects: (3.) Scales in Appendix B; (4.) Freight handling at two-level freight houses and team tracks and multiple-story freight houses, also handling freight by mechanical means, including the relative advantages and disadvantages of the use of freight houses as warehouses in connection with L. C. L. freight in Appendix C; (5.) Freight yard design, suggesting economies in operation in Appendix D; (6.) The arrangement of terminals to reduce preparatory leaving time and terminal arriving of trains, including the matter of main track capacity approaching important terminals in Appendix D; and (7.) The proper size and arrangement of large passenger station facilities as determined by the business handled in Appendix E. It recommended: (1.) That the Tolerances given in Appendix B be approved for publication in the Manual; (2.) That the conclusions in regard to freight houses given in Appendix C be approved for publication in the Manual; (3.) That the conclusions on Freight Yard Design in Appendix D be approved for publication in the Manual; and (4.) That the conclusions on passenger station facilities in Appendix E be approved for publication in the Manual.

Committee—J. R. W. Ambrose (Toronto Term.), chairman; J. G. Wishart (C. R. I. & P.), vice-chairman; Irving Anderson (A. T. & S. F.), J. E. Armstrong (C. P. R.), W. R. Armstrong (O. S. L.), Hadley Baldwin (C. C. C. & St. L.), F. C. Baluss (D. M. & N.), H. M. Bassett (N. Y. C.), C. H. Blackman (L. & N.), C. A. Briggs (U. S. Dept. of Ag.), A. E. Clift (I. C.), R. A. Cook (C. & A.), J. D'Esposito (Chicago Union Station), A. W. Epright (Penna.), E. H. Fritch (A. R. E. A.), Otto

Gersbach (Chicago Jct.), John V. Hanna (K. C. Term.), E. M. Hastings (R. F. & P.), Reuben Hayes (Sou.), R. A. C. Henry (C. N. R.), J. B. Hunley (C. C. C. & St. L.), D. B. Johnston (Penna.), B. H. Mann (M. P.), A. Montzheimer (E. J. & E.), C. H. Mottier (I. C.), C. L. Persons (C. B. & Q.), H. J. Pfeifer (Term. R. R. of St. L.), H. L. Ripley (N. Y. N. H. & H.), H. M. Roeser (Bu. of Standards), C. E. Smith (Con. Engr.), C. H. Spencer (I. C. C.), E. E. T. Tratman (Engr. News-Record).

Appendix B—Scales

The committee's report in 1924 expressed the conclusion that it is impracticable to prepare specifications covering the design and construction of automatic indicating devices for weighing, but that a certain accuracy in weighing should be required and, therefore, work on this subject since the last convention had been confined to obtaining and studying results of tests of heavy-duty automatic scales in railroad service for the purpose of determining what tolerances may properly be specified for such scales used exclusively in railroad service for obtaining weights for the sole purpose of fixing charges for the transportation of weight.

A Committee of Specifications and Tolerances of the Annual Conference on Weights and Measures submitted to the Fifteenth Annual Conference held at the Bureau of Standards in 1922, specifications for tolerances for heavy-duty automatic scales which were received as a report of progress. They were adopted by the Sixteenth Annual Conference in 1923. That portion of the report containing a definition of a heavy-duty automatic indicating scale and the tolerances adopted are here quoted as follows:

"Non-Retroactive Tolerances for Heavy-Duty Automatic Indicating Scales"

"Definition.—A heavy-duty automatic indicating scale is a scale, other than the counter-scale type, in which is embodied or to which is attached a self-acting mechanism, the capacity of which may be equal to or less than the total capacity of the scale, through the agency of which the indicated or recorded weights of variable loads may be obtained. This classification does not include scales which automatically weigh out commodities in predetermined drafts, such as automatic grain hopper scales, packaging scales, etc.

"Note.—The tolerances herein presented for consideration are, as is stated above, not intended to be applied strictly to scales already in use.

"These tolerances are not be construed as applying to railroad track scales, whether or not automatic indicating devices are embodied in or attached to such scales.

"Tolerances.—The tolerances to be allowed in excess or deficiency on heavy-duty automatic indicating scales shall be the values shown in the following table: Provided, however, that the tolerances on the dial or reading face on all these automatic indicating scales shall in no case be less than the value of one of the minimum graduations on the dial or reading face, or one five-hundredth of the capacity of the dial or reading face, whichever is less, except that on such of these scales as have a minimum graduation of one pound or more on the dial or reading face such tolerance shall not be less than one pound. The tolerances on any beam or beams with which the scale may be equipped shall be the same as those specified above, except in cases where the value of the minimum graduation on any such beam is less than that of the minimum graduation on the dial or reading face, or one five-hundredths of the capacity thereof, whichever determines the minimum tolerance on the dial or reading face, in which cases the minimum tolerance on any such beam shall be the minimum graduation on any beam with which the scale may be equipped.

"The minimum tolerance to be allowed on the ratio or the multiplying power of the scale shall be the same as the minimum tolerance allowed on the beam: And provided further, that the manufacturers' tolerances or the tolerances on all new heavy-duty automatic indicating scales shall be one-half of the values specified above.

"The tolerances to be allowed on heavy-duty automatic indicating scales used exclusively in determining weights for the sole purpose of fixing charges for the transportation of freight shall be twice those specified above.

Loads in Pounds	Tolerance, Class A		Tolerance, Class B	
	On Ratio Ounces	On Dial or Beam Ounces	On Ratio Ounces	On Dial or Beam Pounds
50	½	1		
100	1	2		
200	2	4		
300	3	6		
400	4	8		
500	5	10	10	1¼
600	6	12	12	1½
		Pounds	Pounds	
800	8	1	1	2
1,000	8	1	1	2
1,200	10	1¼	1¼	2½
1,500	12	1½	1½	3
1,800	14	1¾	1¾	3½
	Pounds			
2,000	1	2	2	4
2,500	1¼	2½	2½	5
4,000	2	4	4	8
6,000	3	6	6	12
8,000	4	8	8	16
10,000	5	10	10	20
12,000	6	12	12	24
16,000	8	16	16	32
20,000	10	20	20	40
24,000	12	24	24	48
30,000	15	30	30	60
40,000	20	40	40	80
50,000	25	50	50	100

"Note—The values given in the above table are the same as those adopted by the Eleventh Annual Conference for platform scales of the beam type and incorporated in Bureau of Standards Circular No. 61 and Handbook No. 1.

"Explanation of Preceding Table—Class A scales include the following: Scales of the portable platform type; and also scales of the self-contained or dormant and built-in types which are installed inside of a building having side walls and roof, which protect the scale from weather effects and from sudden changes of temperature.

"Class B scales include the following: Scales of the motor truck and wagon types; and also scales of the self-contained or dormant and built-in types which are not installed inside of a building having side walls and roof and which are exposed to weather effects and sudden changes of temperature.

"Note—The latter effect, since it causes the condensation of moisture on the scale parts, often has as serious results on the condition of the scales as have weather effects.

"The values in the columns with the headings 'Tolerance,' 'On ratio' are to be applied to the ratio or multiplying power of such scales with which loose counterpoise or 'bottle' weights are used; namely, those which are manually applied and removed and are not an integral part of the scale mechanism.

"The values in the columns with the headings 'Tolerance,' 'On dial or beam' are to be applied to those parts of such scales not requiring the use of loose weights; for example, the dial, a beam, or 'built-in' automatic or semi-automatic counterpoise or unit weights; namely, those which are automatically or mechanically added and are an integral part of the scale mechanism and not designed to be detached therefrom.

"Tolerance on Weights—The tolerances to be allowed on loose counterpoise or 'bottle' weights used on heavy-duty automatic indicating scales shall be the same as those specified for such weights used on beam scales."

Appendix C—Freight Handling

The committee confined its efforts this year to a consideration of the first portion of the assignment, "Freight handling in two-track-level freight houses and team tracks and multiple-story freight houses."

The question of two-track-level and multiple-story freight houses presents a fertile field for investigation. It was the thought of the committee, however, that the one-level house for many years to come will be the principal type of freight house in this country, and that multiple-story houses will be the exception rather than the rule. It was felt, therefore, that the principal fact to be determined is when the construction of a multiple-story freight house is justified instead of the usual simple type of one-level house. In order to study this problem adequately, it will be necessary not only to develop the facts in connection with the multiple-story freight house, but also to develop similar information in connection with the one-story house in order that a proper comparison can be made of the

economic advantages of the two types of houses when considered for any particular location. The committee, therefore, endeavored in its report to cover, in as complete a manner as possible, the whole question of L. C. L. freight house operation, including both one-level and multiple-story freight houses.

Conclusions

1. The various factors entering into the design of a freight house should be corelated so that no one factor will limit the capacity of the house. Capacity of tail board frontage for receipt and dispatch of freight, gross floor area required in an inbound house per ton of freight handled, width of outbound house to provide trucking aisles and permit proper operation of the house, width of trucking platforms and bridges, width of roadway approach, and elevator capacity are the most important factors to be considered.

2. Variation of the peak hour and seasonal traffic from the average requirements should be considered in determining the size of a freight house.

3. The probable growth of the business to be handled in a freight house for the period of years within which the cost of the structure can be amortized (probably 30 or 40 years) should be considered in the design of the facilities.

4. The present average L. C. L. car loading of from six to eight tons is affected by car supply, character of freight, volume of freight handled and size of car, and will probably continue to increase gradually with the increase in the size of cars.

5. Tailboard frontage may determine the minimum length of house for a given tonnage and should be provided for the full length of the house. The average capacity of tailboard frontage is approximately 1.12 tons per lin. ft. per day and depends on the character and amount of freight handled, and the hourly distribution of flow of freight through the house.

6. The gross floor area of an inbound house should be provided at the rate of approximately 130 sq. ft. per ton of daily capacity of house.

7. The width of an outbound house should be sufficient to provide adequate aisles for trucking and sufficient space for standing trucks and receiving freight but normally need not be affected by the requirements for storage of freight. A width of house of 50 to 60 ft. is adequate for tractor trucking.

8. The cost of tractor trucking depends upon rates of pay, efficiency of labor, trailer loading, number of trailers in train, speed of train, character of freight, condition of trucking floor, quantity of freight and length of haul.

9. The cost of tractor trucking, in dollars per ton, on the basis of an average rate of pay for labor of 51 cents per hour, can be determined approximately by the equation $C^{tt} = 0.14 \div 0.0183d$ in which d represents the average distance in hundred feet that freight is trucked, 0.14 represents the cost of making the trucks into trains and the expense of motors when not actually engaged in the movement of freight and 0.0183d represents the actual cost of moving the freight.

10. The cost of hand trucking, in dollars per ton, on the basis of an average rate of pay for labor of 48 cents per hour can be determined approximately by the equation $C^{ht} = 0.13 \div 0.06d$, in which d represents the average distance in hundred feet that freight is trucked, 0.13 represents the cost of that portion of the trucking operation which is inde-

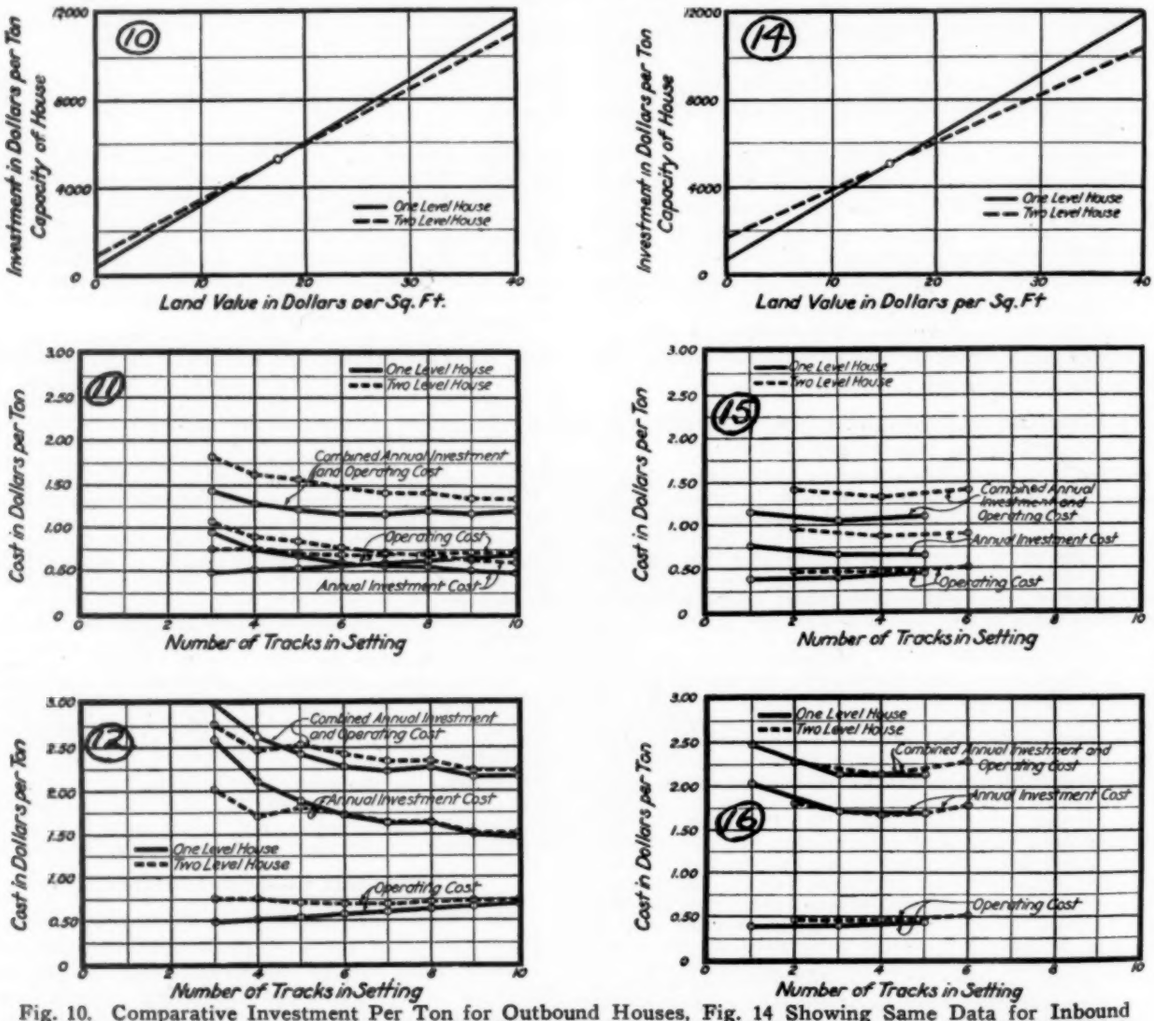


Fig. 10. Comparative Investment Per Ton for Outbound Houses, Fig. 14 Showing Same Data for Inbound Houses. Figs. 11 and 12 Comparative Annual Investment and Operating Costs for Outbound Houses With Land Values at $6 and $20 Per Sq. Ft., Respectively. Figs. 15 and 16. The Same Data in Regard to Inbound Houses

pendent of the distance through which the truck is moved, and 0.06d represents the cost of actually moving the freight.

11. The cost of stowing freight depends upon rates of pay, efficiency of labor, trailer or truck loading, character of freight, relative elevation of car floors through which freight is trucked, quantity of freight handled and number of cars per run.

12. The cost of stowing, which also includes the cost of trucking the freight from the freight house or platform through the cars, in dollars per ton, on the basis of an average rate of pay of labor or 52 cents per hour can be determined approximately by the equation $C_s=0.12+0.0367N$, in which N represents the average number of cars in each run through which freight is trucked for stowing, 0.12 represents the cost of stowing the freight in the cars and 0.0367N represents the cost of moving the freight from the freight house or platform through the cars.

13. Loss and damage claims mount rapidly with careless and unskilled stowing. One man, assigned especially for that work, should be responsible for the stowing of each car in his assignment.

14. Tractor trucking will materially reduce the cost of trucking over hand trucking when the length of house and tonnage handled is sufficient to justify its use.

15. The average trucking distance in an outbound house, where the freight is received uniformly on one side and distributed uniformly to the other, is theoretically one-third the length of the house. In practice, the average trucking distance for this condition approximates 0.3 the length of the house.

16. The modern freight elevator is the only practical means developed to date and generally accepted in freight houses for the vertical transportation of freight.

17. There are two general methods of elevator control—automatic and manual, but opinions differ as to their relative economy. Most new installations are equipped with automatic or push button control.

18. The number of elevators in a two-level outbound house has practically no influence on the average length of longitudinal trucking on the driveway level if they are uniformly spaced, however, the number of elevators influences the average length of trucking on the track level and also affects the capacity of the house.

19. The theoretical distance between elevators which will reduce the average trucking distance to a minimum in a two-level house is represented by the equation $g=\sqrt{\frac{(Pr+E)\,L}{0.015T}}$ in which P = first cost of one elevator; r = annual interest rate; E = annual cost of elevator operation; L = length of house in hundred feet; and T = total yearly tonnage.

20. Spotting cars at outbound freight houses is common practice, the advantages being reduction in length of trucking and space occupied. The objections are the added cost of spotting, and the increased cost of trucking through cars.

21. The cost of spotting and recoupling cars, based on a switch engine and crew cost of $12.50 per hour, amounts to approximately 28 cents per car. These figures do not include cost of switching other than actually used in spotting cars.

22. The outbound setting, where the capacity of the house will permit, is usually left undisturbed during the period of freight house operation, which makes spotting of cars less objectionable from an operating standpoint than at inbound houses, where it is common practice to have two settings per day.

23. The inbound setting should be changed during the noon hour, if two settings per day are required, thereby reducing to a minimum the disturbance to the freight house operation. Where the normal volume of business requires more than two settings per day, expansion of the facilities should be considered.

24. The spotting of cars can be eliminated by constructing platforms between each pair of tracks, connecting the platform to the freight house by a platform at the bumper end of the tracks, and by trucking bridges at intervals in the setting if the length of the setting is sufficient to justify their installation.

25. The annual investment and operating cost with platforms between tracks will exceed the similar cost where platforms are not provided and where cars are spotted if land values exceed $6.00 per sq. ft.

26. The total annual investment cost for a freight house remains practically constant during the life of the structure, the principal variation being due to a change in the value of the land occupied, but the annual investment cost per ton of freight handled varies inversely as the tonnage handled, being lowest when the house is used to its maximum capacity. The initial construction of the house should therefore, if practicable, be proportioned on the needs of the immediate future with provisions for increase in the size of the facilities as the requirements increase.

27. Minimum operating costs can be attained in freight houses of great capacity by locating the setting between two houses connected at the bumper end of the track by a platform.

28. There are advantages in handling both inbound and outbound business in a combination house, so arranged as to have the setting located between two houses connected at the bumper end of the tracks by a continuous platform. One side of the setting can then be used for inbound and the other for outbound business. This arrangement has the advantage of elasticity, as it is possible to vary the number of tracks in the inbound and outbound setting to meet fluctuations in business and also permits easy transfer of freight.

29. Two-level freight houses are particularly adapted to locations where streets and tracks are at different levels, due to topography or grade separation. The elimination of inclined ramps by the two-level house, if not required for other purposes, results in an economy of space to the railroad, and is favorable to the shipper or consignee.

30. Two-level freight houses occupy less land per ton capacity than one-level houses but result in higher building cost.

31. The cost of longitudinal trucking in a properly designed two-level house should be less than in a one-level house, but this is offset, at least in part by the cost of elevating freight.

32. Two-level houses, due to their greater first cost and more permanent type of construction, cannot be altered to meet changing conditions as readily as one-level houses.

33. The development of air rights above a freight terminal, for other than railroad purposes, will probably justify a one-level as compared to a two-level freight house development.

34. The multiple level inbound freight house, as far as economy of space occupied is concerned, has a decided advantage over a one-level house, as the excess storage space required can be provided on a third level above the driveway and working floor space.

35. A two-level house completely eliminates interference resulting from vehicles and locomotives operating on the same level.

36. The length of car setting in a two-level development need not be affected vitally by the distance between streets, as longitudinal trucking can be done below the streets at the car floor level.

37. A two-level outbound house as compared to a one-level outbound house should result in a very material reduction of stowing costs if a loading platform is located in the middle of the setting on the lower level.

38. No economy in total investment and operating cost for two-level houses, as compared with one-level houses can be obtained where the land value is much below $20.00 per sq. ft. With higher land values, the two-level house becomes more economical.

39. Two-level combination inbound and outbound freight houses are more economical in land, and therefore have lower combined annual investment and operating cost than isolated two-level inbound or outbound houses.

40. Both inbound and outbound houses, as a general proposition, result in the lowest combined annual investment and operating cost when constructed of the shortest length consistent with providing adequate tailboard frontage.

Appendix D—The Arrangement of Terminals to Reduce Preparatory Leaving Time and Terminal Arriving of Trains

It was the purpose of this report to outline the general principles of yard design and operation which will make it possible, under proper supervision, to reduce to a minimum the period of time that the train crew and engine crew of a road freight train need be on duty before departing from their initial terminal and after arriving at their final terminal.

Conclusions

In order to reduce to a minimum the time that the train crew and engine crew of a road freight train need be on duty before their train is moved out of the initial terminal yard and after it has offered to enter the final terminal yard when these yards are such as handle a considerable number of trains:

1. The length of the tracks in the receiving yard or the departure yard should be such that each track will accommodate a complete train including one or more assisting locomotives where such locomotives are used.

2. The number of tracks in the receiving yard or the departure yard should be such that there will be a track available for receiving an arriving train when it offers to enter the yard or for assembling a departing train when necessary.

3. The gradient of the tracks in the receiving yard or in the departure yard, if adverse to the forward movement of a train should be less than the ruling gradient encountered by that train during its road trip.

4. The connection between the receiving yard or the departure yard and the main track should be as direct and as simple in alignment as practicable.

5. A pulling in or a pulling out track, or both, somewhat longer than a maximum train length, or an inbound or outbound freight running track, or both, extending to or beyond the first telegraph office outside of the terminal yard and operated as a freight main track should be provided as required.

6. The location of the mechanical plant should be such that the aggregate mileage run by all locomotives in moving between it and the receiving yard and the departure yard will be a minimum and special engine running tracks should be provided and so arranged as to eliminate, in so far as practicable, all conflict between these movements and all other work being done in the yard.

7. Compressed air at suitable pressure should be piped into both the receiving yard and the departure yard and the air brake equipment should be tested by the yard forces as soon as the cars of a train are received or assembled in either of these yards.

8. The duties to be performed by the train crew and engine crew before their train has moved out of the initial terminal yard and after it has offered to enter the final terminal yard should be made simple and easy to accomplish.

9. The place where the train crew sign on duty should be the place where they receive train orders, waybills and the train list if this is prepared by yard forces and should be located convenient to the head end of the departure yard.

10. The place from which train supplies are obtained should be so located as to facilitate the placing of them on the caboose by either the train crew or yard forces as may be found the more economical.

11. The place at which the train crew sign off duty should be that at which the conductor delivers the train list, waybills and report of bad order cars and should be located convenient to the receiving end of the receiving yard.

12. The locomotive should be moved out of and into the engine house, furnished with coal, water, and other supplies, and have the fire and ash pan cleaned by mechanical department forces.

13. The place at which the engine crew sign on duty should be located convenient to the point at which they take charge of the locomotive.

14. Adequate space and facilities should be provided for the engineman to make the initial inspection of the locomotive before moving it from, and the final inspection after delivering it at the mechanical plant.

15. Before the locomotive arrives in the departure yard all bad order cars or cars for which no waybills are available should be switched out and the final set up fully charged with air.

16. It may be economical to have switches to be run over by the locomotive in moving to and from the mechanical plant and by the train in moving to and from the main track handled by switch tenders or interlocking plants.

17. The place at which the engine crew sign off duty should be that at which the engineman delivers the work list and should be convenient to the point at which the final inspection of the locomotive is made.

18. The departing time of each train should be fixed to the mutual satisfaction of the yardmaster and the dispatcher and each train should have all necessary orders and be ready to depart on time.

19. The dispatcher should advise the yardmaster of the probable arriving time, length and amount of work to be done on each train so that he may be prepared to handle it promptly when it offers to enter the yard.

20. The point to be constantly borne in mind in the design of a new yard, or in planning its operation, and in the study of an existing yard with a view to reducing the initial and final terminal times and delays which occur in it, is that where the total cost of operating, maintenance and fixed charges on the additional or improved facilities can be shown to be less than the cost of the terminal time and delay which will eliminate the expenditure for these facilities, all other things being equal, is justified.

Appendix E—The Proper Size and Arrangement of Large Passenger Station Facilities

The sub-committee studying passenger terminal facilities and the requirements for large passenger stations, reporting at the annual meetings in 1923 and 1924 had for its primary object the collection of data in connection with, and the study and analysis of, the facilities essential to the comfort and convenience of the through traveler, as determined by the relative volume and intensity of business handled. Incidentally much valuable data was collected and presented in connection with the commuter and his needs and his desires as expressed by his actions.

Segregation of Service

Where commuter business is heavy it is desirable to provide for separation between it and the through business so far as feasible. This may be accomplished by handling the two classes of service on different levels, as is done at Grand Central Station, New York, and, as provided for when it becomes necessary, at South Station, Boston; by providing facilities at the side, as is done for the Long Island service at Pennsylvania Station, New York, or by passing commuter service beyond the terminal provided for through service, as is done at the Twelfth Street Station of the Illinois Central, Chicago. The two-level proposition involves electrification of the suburban zone before it is feasible, and would be adopted only where land values were high enough to warrant it.

Conclusions

1. Transfer passengers occupy a station for a maximum length of time and require more extensive facilities per passenger than resident through passengers.

2. Commuter passengers occupy a station for a minimum length of time, occupy less space and move faster than the through traveler and therefore requirements in the way of station facilities per passenger are substantially less for a commuter than for a through traveler.

3. Decreasing the time interval between incoming and outgoing trains decreases requirements per passenger for waiting room space and for certain other facilities.

Increased business tends to increase the number of trains, decrease the waiting time and equalize the spread of minutes-waiting per passenger over the rush hour period.

4. The number of passengers handled during the rush hour does not, definitely and alone, determine the size or number of facilities required. Local conditions must be studied as they affect requirements for any particular situation.

The size or number of facilities must be modified to make allowance for:

(a) Time of arriving and departing trains and the span in minutes between them.
(b) The ratio between passengers commencing or terminating their journey and transfer passengers.
(c) Number of holdover passengers arriving or departing outside of the rush hour but occupying space and requiring service during a portion of the rush hour.

5. When commuter business is heavy it is desirable to separate the through and commuter service, so far as it is feasible to do so. This may be done by handling the two classes of service at:

(a) Different levels. This requires electrification.
(b) At different sides of the station.
(c) At different terminals, one beyond the other.

6. Sufficient throat tracks should be provided to permit at least two simultaneous parallel movements. Flexibility sufficient to provide for complete interchange of routes is desirable.

7. A commuter passenger occupies platform space for less than one-half as many square-foot-minutes as a through passenger, the ratio being:

For the through traveler, 15 sq. ft. moving at 220 ft. per minute.

8. Exit turnstiles for handling large crowds are an inconvenience, slow up traffic and should be avoided.

9. The concourse should be sufficiently broad to permit the gathering of a full trainload at a gate without a blockade.

10. Incoming passengers should be able to go naturally and directly from the concourse to the street without passing through waiting room or blocking the waiting room exits.

11. The concourse should be so arranged that it will not be a convenient thoroughfare for people who are not passengers.

12. Indicator boards are the only directional information required, as a rule, by commuters. They should show track number, scheduled leaving time and names of stations at which the train will stop.

In case a departing train is shifted to a track other than the one from which it regularly leaves, a display board should be posted on the indicator board for the regular track before that gate is opened and generally not less than five minutes before the actual leaving time.

13. Posters, giving the time for leaving, the regular track number, the destination of train, should be displayed at a few conspicuous points in the waiting room and concourse.

14. Concessions for the sale of commodities and the rendering of service, catering to the needs and desires of the traveling public, should be provided for the convenience of passengers.

The number and character of these concessions can be greatly expanded in terminals located in cities of large size, with benefit and profit to all concerned.

Concessions, to be successful, must be so located as to be conspicuous and easy of access. They must be neat and attractive in appearance and well lighted, and concessionnaires should be experienced, responsible and progressive.

Booths opening directly onto the corridor where service is rapid, appeal more to the commuter, while stores appeal to the through traveler and particularly to the transfer passenger who has time to spare.

15. Windows opening directly onto the concourse for the sale of local tickets are desirable.

Where commutation tickets coincide with the calendar month and the number issued is large, portable booths located in the concourse may be desirable during the last two or three days of the month.

16. Loop tracks for turning trains, both in substations and in the coach yard, speed up the service and greatly increase capacity, especially for handling suburban business—often at a minimum of expense.

(Diagrams showing size or number of facilities required for varying proportions of mixed through and commuter service will be found in the Proceedings, Vol. 26, commencing at page 745.)

Discussion

[The report was presented by J. R. W. Ambrose, chairman, who expressed the committee's regret at the death of one of its members, H. L. Douglas, Jr. It was *moved and carried that the tolerances for heavy duty automatic indicating scales be adopted for publication in the Manual.*]

L. J. F. Hughes (C. R. I. & P.): It may be true that truckers in pushing the trucks to freight houses do perform in accordance to the mathematical laws laid down by the equations in this report. It also is somewhat of a marvel to me that so commonplace a thing as the trucking business in a railroad freight house can be computed by the use of integral calculus. Nevertheless, I doubt whether this purely academic discussion gives any real value to the problem of designing a freight house, because as has been stated, the conditions assumed are purely ideal. There is also a statement that E. H. Lee (C. & W. I.), found from observation of six freight houses an average trucking distance equal to 0.556 L for the round trip, including the return of the empty truck, or equivalent to an average trucking distance of 0.278 L for the truck moving with load. Such information obtained from actual observation is of vastly more importance than the mathematical gymnastics as have been included.

It was moved and carried that the conclusions in Appendix C be included in the Manual.

(The recommendations of the committee in Appendices D and E were adopted without discussion and the committee was dismissed with the thanks of the Association.)

Report of the Committee on Ties

The report of the Committee on Ties included the usual report on substitute ties in which the results at the various test points were discussed in detail, as well as shown in a tabulated summary. Further study relative to this class of ties was evidenced by a report on the principal causes of failure of substitute ties and methods whereby these might be overcome. A suggested design was submitted with the recommendation that interested roads build a sufficient number to secure a thorough test of them under actual track conditions. Foreign woods for tie purposes were discussed and conclusions submitted for inclusion in the Manual. A specification for tie plugs was also submitted for inclusion in the Manual. W. A. Clark has been chairman of this committee for 4 years and a member for 12.

W. A. Clark
Chairman

THE COMMITTEE presented reports covering the following subjects: (1) Substitute Ties in which was included the usual report on ties under test in an Appendix A and also one on the design of a substitute tie in Appendix B; (2) Ties of Foreign Woods in this Country in Appendix C; and (3) Specification for Tie Plugs in Appendix D. It was recommended that the reports on substitute ties, ties of foreign wood, be received as information, and specification for tie plugs, in Appendix D, be approved for publication in the Manual.

Committee: W. A. Clark (D. & I. R.), Chairman; W. J. Burton (M. P.), Vice Chairman; M. S. Blaiklock (C. N. R.), R. S. Belcher (A. T. & S. F.), Bernard Blum (N. P.), E. Betts (S. P.), H. A. Cassil (P. M.), J. K. Conner (L. F. & W.), R. L. Cook (C. of Ga.), E. L. Crugar (I. C.), J. F. Deimling (M. C.), A. R. Dewees (P. M.), S. B. Fisher (M. K. T.), John Foley (Penna.), G. F. Hand (N. Y. N. H. & H.), H. C. Hayes (I. C.), R. M. Leeds (L. & N.), G. P. MacLaren (C. N. R.), A. F. Maischaider (C. C. C. & St. L.), A. J. Neafie (D. L. & W.), G. P. Palmer (B. & O.), L. J. Riegler (Penna.), J. H. Roach (N. Y. C.), S. E. Shoup (K. C. S.), C. U. Smith (C. M. & St. P.), J. W. Williams (W. P.), W. W. Wysor (United Rys. & Elec.), R. C. Young (L. S. & I. & M.)

Appendix B—Design of Substitute Ties

If a substitute tie could be produced at a cost no greater than the treated all wood tie, it would have to

last only slightly longer than the wood tie to justify its use. But no substitute tie has yet been produced which has not considerably exceeded the wood tie in cost and which, therefore, is required to have a life greatly in excess of that of the wood tie in order to reduce the annual cost to no greater than for the wood tie.

Corrosion

Corrosion is no doubt the most important and at the same time the most difficult to overcome of the causes of failure. The iron or steel of a tie is under conditions much more conducive to corrosion than almost any other part of a railroad. Moisture is retained by the ballast, the cinders almost always present furnish the acidity, and the abrasion with the ballast under traffic tends to remove protective coatings or to expose fresh metal where there is no coating. This same difficulty from corrosion, although not so pronounced, is had with tie plates and other track fastenings. In the last few years tie plates containing a small percentage of copper have been under trial and the results so far secured point to this method as a possible solution for the tie problem.

Rail Fastenings

The same difficulty with corrosion has frequently been the principal cause of the failure of fastenings on substitute ties. This applies to those ties mainly composed of concrete as well as those made principally of steel. In addition, however, to the failures due primarily to corrosion of fastenings, other ties have been discarded because the fastenings did not provide for the essential adjustments occasioned by changes of gage or width of rail base and for vertical play between the underside of the rail fastening and the top of the rail base.

It would seem unreasonable to go to any expense to provide for variation greater than required for one step. The greatest variation for one step on the inside flange is ¼ in. from 105-lb. to 120-lb. N. Y. C. rail. The greatest variation for outside flange is 47/120 in. for the step from 100-lb. to 130-lb. P. S. rail. The committee recommended, therefore, that where possible an allowance be made of ¼-in. for the inside flange and ½-in. for the outside flange.

Allowances to enable adjustments for rail wear are desirable and are in a measure provided for by the above allowances for different rail sections. It is questionable as to how much re-gaging is done because of rail wear. Give in spikes, tie cutting and cant seem to be the chief causes of re-gaging rail, that due to rail wear being relatively small.

If the substitute tie has wood blocks for supporting the rail the chief causes noted above will apply, but re-gaging can be done as with wood ties. If the substitute tie is of steel or concrete with a metal bearing, the chief causes above will be eliminated. The committee recommended, therefore, that in designing a substitute tie, no additional expense be incurred in providing allowances for rail wear.

The fastenings should be so designed as to provide a vertical free way where desired, to take care of rail deflection, irregular conditions of surface, etc.

Provision in substitute ties for a slight inward cant of the rail is desirable, and provision against outward cant is necessary. In ties having wood blocks, allowance should be made for extended tie plate area outside of the rail; in steel and concrete ties, this is not as necessary, though desirable.

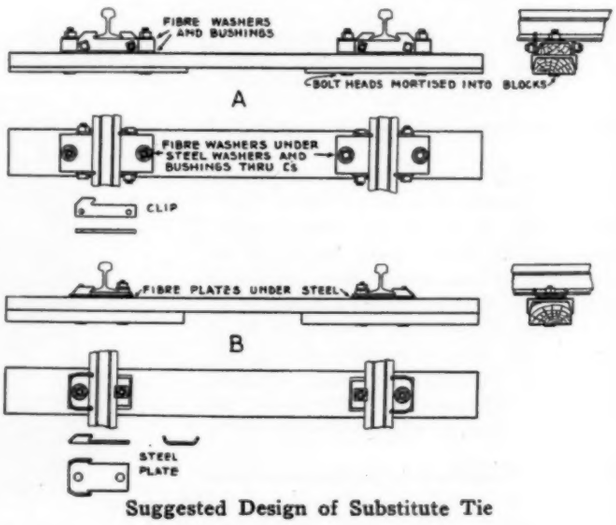
Insulation

One of the most troublesome features of most substitute ties has been the insulation between the two rails. The commonest expedient is to place a thin fibre plate between the top of the tie and the bottom of a flat bottomed tie plate. Failures of this type of insulation are usually caused by the pounding of the plate due to looseness of the assembly and to leakage around the edges of the fibre plate. Such leakage is greatly promoted by the accumulation of steel particles and dust worn off from wheels and flanges and dropping on the plates. If the edge leakage can be overcome or sufficiently reduced, a fibre plate ⅛-in. thick will probably furnish sufficient insulation. This thickness is used in the insulated lap joint gage plate (A. R. A. Sig. Sec. 1454) as recommended by the Signal Section and approved December, 1923. It is general experience that insulated switch rods give very little trouble and require practically no attention after installation.

The committee therefore recommended that if the substitute tie be insulated by fibre plates, such plates be ⅛-in. to ¼-in. thick, of ample size, and that the fibre plates project beyond the base of the tie plate ¼-in. all around to retard leakage across the edges of the fibre plates. Means should be provided to hold the steel and fibre plates tight to the tie, so that all play will be between the base of the rail and the steel plate. Other materials at present being tested for this purpose are bakelite and soft rubber sheets about one-fourth-inch thick, but data as to results is not available. The question of satisfactory means of insulation with substitute ties is one of those requiring actual tests and development resulting therefrom.

Designs of Substitute Tie

The substitute tie, two variations of which are suggested in the drawings herewith, is purposely designed to be made from standard sections, although special sections would probably be better. The committee fears that if special sections were recommended, few, if any, ties of this general form would be tested. The ties shown can be readily made in almost any railroad shop and it is hoped that a considerable number may be tested.



Suggested Design of Substitute Tie

The insulation of the bolts from the tie plates and main channels is intended to be obtained with fibre bushings and washers. The accommodation to rails of different base widths is intended to be made by changing the clips or the tie plates. These ties contain no provision for shimming and they would therefore probably not be suitable for use where extensive shimming is practiced.

The blocks under the main channels can be made of treated timber, or of concrete, or other material. If of treated timber, because of their relatively small size and because of their protection from excessive stress or

crushing, these blocks can be made of cheap material such as second-hand car material. It would be very desirable to use copper content steel for these or other ties to be tested.

The committee recommended that these and similar ties be tested under traffic. As defects are developed by the tests, efforts should be made to overcome them by such improvements and changes as are suggested by the results of the first tests and in this way progress made towards satisfactory ties. While no substitute tie can compete with treated wooden ties on an annual cost basis with the present relative prices for timber and substitute materials, it is nevertheless desirable to have developed the best substitute tie before possible changes in the relation between timber and substitute material prices might make the substitute tie desirable for extensive adoption.

Appendix C-Cross-Ties of Foreign Woods

The information available to the committee does not hold any hope that any shortage which may occur in the supply of American ties can be met by the importation of foreign woods which are both durable and strong. Some of the Central and South American countries which seemed likely sources of supply several years ago are importing ties—their native woods are not sufficient or suitable. It may be that preservative treatment will make useful in tropical countries woods which now give their railroads short service and that the supply of such woods in some countries will thus be made available for export; but there are no present indications that ties of foreign woods which will give satisfactory service in the United States, untreated, are to be had in large quantities at competitive prices.

According to C. D. Mell, in an article in the *Railway Age* for March 18, 1921, page 744, "In considering this problem one must bear in mind that there is a demand locally in all the tropical American countries for logs and lumber from the native forests. The very best timbers are the kinds in common use, and in almost every instance they are the kinds that would be available for ties. The market price for such wood is based on what the native labor is willing to get the material out of the forest and deliver it to the market for. The cheapest way, and at present the only practical way, to get these logs out is that followed by the native woodsmen, whose wages are calculated on their native monetary basis. The price set by local operators for logs delivered to market will be more advantageous to American operators than that which their logs of similar quality and sizes would bring, if they were reduced to ties and delivered to the United States."

Although Europe as a whole has no surplus forest resources to export, it may be that the need for money in the countries which have wood to spare and the lack of money in the adjacent countries which are normal customers for this forest produce will bring about the importation into the United States of the woods which are used for ties in Europe. However, the present prices at which ties are produced along the railroads in this country will have to advance before imported ties can compete under the handicap of ocean freight.

Since southern South America lacks sufficient timber to supply its own needs and the vast stores reputed to exist in the Upper Amazon are not likely to be available for a long time, any proposals for ties of tropical woods worthy of serious consideration, so far as reliable supply is concerned, would be confined to northern South America, Central America, and Mexico.

Confusion in the names of foreign woods may have resulted in some of the poor service from some woods being charged against better woods. Any railroad which undertakes to test ties of foreign woods should have the woods identified by a dendrologist, so as to be in a position to know what wood it is handling and to avoid it or get it again as may be desired. Before giving any consideration to a tropical wood, information regarding it should be sought in "Timbers of Tropical America" by Record and Mell, which is the best publication in English regarding such woods.

Appendix D—Specification for Tie Plugs

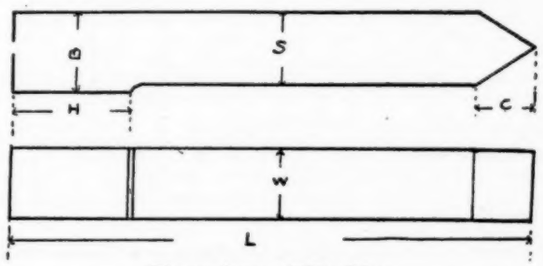
Softer woods are preferable for use as tie plugs, both treated and untreated, as they fill the spike hole better, absorb moisture, swell and stay in the hole and are less liable to split the tie than hardwoods. Tie plugs should be driven to full depth and with the widened head parallel with the tie so as to take up any enlarging of the hole back of the spikes. Treated tie plugs should be used in all treated ties.

The following specification for tie plugs is recommended:

Material—Kinds of wood: The following kinds of wood are suitable for use in the manufacture of tie plugs: Ash, beech, birch, catalpa, cedar, cherry, chestnut, cypress, elm, fir, gum, hackberry, hemlock, larch, locust, maple, mulberry, oak, pine, poplar, redwood, sassafras, spruce, sycamore and walnut.

General Quality—Tie plugs shall be sound, seasoned, straight grained, and free from knots or other defects.

Design—The following general design is recommended (see illustration):



Dimensions of Tie Plug

Dimensions—Tie plugs shall be of two general sizes for 5/8-in. and 7/8-in. standard spikes. Before manufacture, producers will ascertain which of the two sizes are required. The following dimensions are recommended:

	(See diagram)					
	B	S	H	C	W	L
For 5/8-in. spike	11/16-in.	5/8-in.	1-in.	1/2-in.	5/8-in.	4 1/2-in. to 5-in. or same length as spike used.
For 7/8-in. spike	5/8-in.	7/8-in.	1-in.	1/2-in.	7/8-in.	4 1/2-in. to 5-in. or same length as spike used.

Manufacture—Tie plugs shall be made in multiple or singly.

Delivery—Multiple plugs shall be shipped in bundles of multiples of 100 securely tied by wire. Single plugs shall be shipped in bags as desired by the purchaser.

Discussion

[The report was presented by W. A. Clark, chairman, who *moved the adoption of the specifications for tie plugs for inclusion in the Manual. On motion of Hunter McDonald (N. C. & St. L.) the specifications were amended to provide that all tie plugs shall be treated. The amended specifications were adopted for publication in the Manual.* The committee was dismissed with the thanks of the association.]

Report on Economics of Railway Labor

No single factor exerts a more direct influence on the efficiency of maintenance of way work than its orderly prosecution throughout the year. The Committee on Economics of Railway Labor in its report discusses this question thoroughly in two appendices, one on standard methods for performing maintenance of way work and the other on methods of programming maintenance of way work. The first deals with the establishment of standard schedules as units of performance in order to secure the most effective organization of the forces. The second deals with such vitally necessary factors as budgets, equalization of expenses, division programming and their relation to the economical application of labor. C. C. Cook has been chairman of the Committee on Economics of Railway Labor for two years and a member for the last five.

C. C. Cook
Chairman

THE COMMITTEE presented reports covering (1) standard methods of performing maintenance of way work and the establishment of units of measure of work performed in an Appendix A; and (2) methods of programming maintenance of way work looking to the most economical application of labor in an Appendix B. It recommended that Appendix A be received as information and that the conclusions of Appendix B be approved for publication in the Manual.

Committee: C. C. Cook (B. & O.), Chairman; W. H. Penfield (C. M. & St. P.), Vice Chairman; Lem Adams (U. P.), M. H. Beard (B. & O.), A. F. Blaes (I. C.), A. S. Butterworth (M. S. B. & P.), H. A. Cassil (P. M.), A. Craine (C. B. & Q.), G. C. B. Dunn (C. N. R.), John Evans (M. C.), J. L. Haugh (U. P.), E. T. Howson (*Railway Age*), C. E. Johnston (K. C. S.), Col. F. G. Jonah (St. L.-S. F.), J. D. Keiley (C. & O.), J. W. Kern, Jr. (I. C.), M. F. Longwill (Wab.), J. B. Mabile (C. R. I. & P.), W. A. Murray (N. Y. C.), R. L. Pearson (N. Y. N. H. & H.), A. N. Reece (K. C. S.), R. L. Schmid (N. C. & St. L.), F. M. Thomson (M. K. T.), R. C. White (M. P.)

Appendix A—Standard Methods for Performing Maintenance of Way Work

Standard schedules, or units of performance, should be established with great care, as it is essential that they be correct and that the organization of the gang and method of doing the work are the best that can be worked out.

The standard performance, or 100 per cent efficiency, is the output of a first-class gang working at a speed which can be continuously maintained without physical harm to the men, following an approved method of doing the work and consisting of the most effective number of men for the kind of work to be done.

To arrive at the 100 per cent standard, first-class gangs are to be selected and detail time studies made of the performance, the time studies being divided into as many moves and as much detail as possible in order that the various studies may be compared in detail and a standard method worked out which will eliminate all unnecessary moves. If it appears that an improvement can be made, the organization of the gang and the method of doing the work should be altered and new studies made. When the most satisfactory organization and method has been found, a final detail study is made of the performance of the gang, and this is established as 100 per cent efficiency and issued as a standard schedule. In this way schedules may be established for all of the more important items of maintenance work.

Incidental to standard methods in maintenance of way work is the feature which will provide for an equitable distribution of the available track force to the various sections. A procedure which the committee suggested for consideration is the reduction of all features of track to the equivalent of one mile of first main track. A table of values, derived from actual cost extending over a period of years, for a main line division which was the subject of special study, follows:

One mile of first main track equivalent to:

- 1.15 miles of second main track.
- 1.33 miles of third or fourth main track.
- 2.00 miles of branch line track.
- 2.00 miles of passing and thoroughfare track.
- 3.33 miles of yard tracks—
  - 12 main line switches.
  - 20 side track switches.
  - 10 railroad crossings.
  - 12 city street crossings.
  - 25 to 50 country road crossings.
  - ½ mile of track pans.
  - 4 miles of ditches.

For the purpose of elasticity in use of the above form to meet the changing conditions of various elements of the track it is suggested that the condition of the main elements per section be stated monthly, and a "Condition per cent" of the whole section determined. This result applied to the equivalent mileage gives the equated mileage for the section. The ratio of the equated mileage of the section to the total equated mileage of the division determines the number of men to be allotted to that section from the total number of men allotted the division.

This force distribution plan is a product of the application of standard methods and schedules and is a development of the methodical direction and measurement of track work. It was described simply to indicate the form in which it may be developed.

The report of 1924 continued the studies along the lines recommended in the report of 1922 and embraced several detailed time studies on renewing cross-ties and rail, and statistical data on the cost of various items of track work. In this report several methods of performing cross-tie and rail renewals were evolved and a substantial step was made toward the selection of standard methods of performance and units of measure therefor.

During the year the committee has endeavored to concentrate on detailed time studies of cross-tie renewals and rail renewals out of face, for the express purpose of making recommendations of the best methods of performing these two major operations in track work, looking toward the establishment of units of measure of the work performed. The report consisted of four groups

of exhibits covering: renewal of cross-ties; renewal of rail out-of-face; hand ditching, and other track work items (including renewing and cleaning ballast, and statistical cost data of various maintenance of way operations).

Conclusions

It is the conclusion of the committee that, with the forms and principles adopted and published in the 1922 Supplement to the 1921 Manual and as contained in the Proceedings of 1922, in combination with the various studies published in the 1924 Proceedings and those attached to this committee's report, it has demonstrated conclusively the practicability of these principles, which should enable any carrier to prepare the necessary data for comparison of work between gangs, supervisors' districts or divisions, and by the use of the form suggested in compiling cost data on various items of maintenance of way work that the cost of this work or different items of work, between different supervisors' districts or divisions, may be readily compared, and that these results may be compared with results of similar work on different railroads as the occasion may warrant, and that the relative quality and economy of the work can only be compared on such items of work where the conditions may be compared or the quality judged by inspection.

The above conclusions are reached due to the wide diversity in conditions and the varying practices of different carriers, and the necessity of following different practices in various parts of the country. It was not felt to be practical for the committee to attempt to establish for general application standards of performance for each item of work. The committee has submitted certain principles supplemented by certain detail, which it felt were flexible enough for application to any condition of work or size of force.

Appendix B—Methods of Programming Maintenance of Way Work

No single factor exerts a more direct influence on the efficiency with which maintenance of way work is handled than its orderly prosecution throughout the year. This necessitates the preparation of a budget in which the funds available are allotted to those projects which it is considered most important to carry on. When this budget is approved and the amount of work to be done fixed, it is then necessary to prepare a program or schedule for this work if it is to be done to the best advantage. It is essential that the budget be approved and the program completed sufficiently in advance to enable the materials to be assembled and the forces to be organized to the best advantage. It is then equally important that executive, operating and engineering officers adhere to this program as strictly as possible, for if deviations in even relatively unimportant details are permitted, the entire program will soon become ineffective through other and more serious interruptions.

It is the common practice to do the maximum amount of work when traffic is heavy and earnings good, although it is at this time that men are most difficult to secure and of the poorest quality, wages highest and the cost of doing work increased by the heavier delays from traffic. While the financial condition of some roads may make this method necessary, this condition is not necessary to the financial security of the average road and it can effect large economies if it is willing to forego possible adverse showings in net earnings for certain months in order to secure improved earnings at the end of the year.

To secure the most effective results from a program, it should be applicable throughout the entire department. It should be system-wide in scope and should be extended down to the individual gangs, for it is only where all activities are co-ordinated that the best results are secured. For this reason the committee sub-divided the consideration of this subject into three sections, each of which was made the subject of a separate report. These sub-divisions are as follows: (1) The preparation of a maintenance budget and program and the equalization of maintenance of way and structure expenses for a system; (2) the extension of this program to the track work of the local division supervisor or roadmaster and his foreman; (3) the preparation and application of a program for the maintenance of bridges and other structures.

The Budget

A system budget of maintenance of way and structures expenses should be based upon the physical requirements of the property, modified to conform to the authorized annual expenditure. Primarily the quantities of rails, cross-ties, switch ties and ballast required for the year to meet the physical standard set for the property should be stated. The labor required to apply these materials can then be determined in man-hours or in terms of money value. These conform to sub-accounts (a) (b) (c) of Account No. 220. Other items of track labor falling principally within the following accounts cannot be stated readily in terms of the physical requirements for the year, but they can be estimated upon the most reliable data available to each carrier and added to the foregoing to determine the total amount of track labor required.

Account 202. Roadway maintenance.
Account 220. (d) to (h) inclusive, track maintenance and other expenses.
Account 221. Right-of-way fences.
Account 225. Crossings and signs.
Account 272. Snow and ice.

Bridge, building and signal maintenance material and labor may also be determined from the records of each carrier as appear most reliable and stated separately as to material and labor.

A grouping of other items entering into maintenance of way and structures expenses can be made under the following headings:

Work trains.
A. F. E. operating charges.
Transportation department charges.
Maintenance of equipment department charges.
Miscellaneous.

A budget may be prepared for the year, sub-divided to indicate the expenditures to be made each month and then authorized in its entirety, or it may be authorized from month to month or from quarter to quarter. It is the more common practice to authorize expenditures monthly in order to afford an opportunity for the adjustment of a program to correspond with earnings. This adjustment, however, defeats the purpose of a budget in large measure since it insures little or no continuity of program from one month to another. To overcome this defect in part the Union Pacific has developed a plan of quarterly budgets whereby it authorizes the expenditures for each month by quarters. Even more effective is the preparation of a budget for the entire year and the authorization of appropriations on that basis. A similar budget can be prepared for each region or district of the system conforming to the jurisdiction of the general officer in whom is vested the responsibility for the maintenance of the property and the expenditure of funds. With such authorities in hand, the officer in charge of maintenance is in position to develop a program of work for the season.

Equalization of Expenses

The deterioration of railway property is fairly uniform throughout the year depending in part on the elements and in part on the wear and tear of use. The maintenance of the property to overcome this deterioration, however, is not uniform, for because of climatic conditions it is necessary to concentrate a large part of this work in the spring and summer months. This leads to abnormally low expenditures and resulting high net earnings during the winter months when the work of repair fails to keep pace with the deterioration and the reverse

during the summer. To overcome this condition in part it has long been the practice of many roads to distribute the charges for one or all of their heavier renewals, rails, ties and ballast, uniformly throughout the year. While this practice tends to distribute the charges in proportion to the wear and tear on the property so far as these items are concerned and also tends to curb in part the necessity for retrenchment when traffic falls off, it affects only a part of the charges, for it leaves the largest item of all and the one which suffers most from fluctuations, namely, labor, subject to direct charge as expended and thereby to curtailment.

To reduce the incentive for these measures and thereby to promote economy of maintenance the Interstate Commerce Commission, in Section 19 of its special instructions for the classification of operating expenses, effective July 1, 1914, has authorized the railways to equalize their monthly charges for the repair of fixed improvements by including in appropriate primary accounts a uniform proportion of the amount of authorized estimates of such expenses for the year.

By an order of the Commission at a session on June 2, 1924, a revised Section 19 was submitted which permitted equalization of authorized budgets or estimates for maintenance of fixed improvements, by dividing such authorized estimates into equal parts corresponding to the number of months remaining in the year after the adoption of the maintenance program.

The order further specifies Account 280, "Equalization Way and Structures," for showing each month the adjustment necessary between actual expenditures included in the other primary accounts and the equal monthly proportion of the estimated or authorized maintenance expense for the period.

The authorization by the Commission of such optional procedure on the part of carriers is a recognition of the principle of freedom of action which should rest with public service corporations, and may further be construed as a suggestion to carriers of the opportunity provided for efficient practice, which should not be lost upon officers of railroads charged with the responsibility of efficient and economical management of their departments of way and structures.

It should be noted that equalization as provided for in the existing order of the commission is charged to the one account—280. It is purely an accounting transaction. Actual expenditures to the individual primary accounts are made as customary; there is therefore no confusion as to accounts nor any question as to the facts of the actual expenditures. The application of the equalization charges or credits in the one account so as to give equal monthly total expenses was made possible by the later and existing order of the Commission.

It is apparent that the fiscal policy of some roads may cause it to be inexpedient for them to divide their annual maintenance expenses into 12 equal parts or into any number of equal parts corresponding to the number of remaining months following the preparation of the budget as provided by the present order of the Interstate Commerce Commission. The optional use of this order and the latitude afforded by it would put no restriction on such carriers, while permitting many of the roads to take advantage of its provisions in the economical programming and execution of their work. Further economies in maintenance are also possible through the use of maintenance reserve accrual accounts which would not be subject to the requirement that they be cleared at the close of each year, and it is suggested that carriers be given more freedom of action to adopt such further means as are best suited to their individual conditions.

In the extension of its season's program for track maintenance to the local sub-divisions and sections, the Illinois Central has, so far as the committee has been able to ascertain, developed a plan more complete than any other road.

On the Illinois Central, so far as practicable, a regular maintenance budget is prepared at the beginning of the year to be followed during the current working season. This in turn has been distributed among the various divisions, where it is allotted to the different supervisors, and these men in turn plan with their foremen the work to be performed on each section.

In preparing an annual maintenance of way budget for the system, the different divisions are requested to submit recommendations for the amount of labor and materials of the major items to be used.

In arriving at the data necessary for the preparation of a carefully worked up division budget, roadmasters discuss contemplated work with their supervisors, and when possible make a motor car trip over their various districts, or at least part of them, accompanied by the foremen over their sections. The need for the various kinds of work is observed carefully and following this a summary of work to be recommended is made for the division as a whole. This includes renewals of rail, ties and ballast, number of tie plates and rail anchors required, the amount of track to be surfaced, ditching to be done, etc.

Division recommendations, after completion, are forwarded to the general superintendent's office, where they are turned over to the district engineer on the general superintendent's staff. The district engineer analyzes the division recommendations and then forwards them to the engineer maintenance of way with his recommendations and those of his general superintendent. The engineer maintenance of way compiles a consolidated report for the system and presents it to the management, outlining clearly the requirements for the ensuing year, and how the expenditures are to be distributed by months.

So far as rail, ballast and tie renewals on the Illinois Central are concerned, a reserve fund is set up and the expense thereof distributed equally over the twelve-months period. This permits the handling of rail, tie and ballast programs without interference so far as retrenchments are concerned, and has worked out very satisfactorily.

Although in the early part of the year a maintenance budget or program is worked up, due to various conditions that arise from time to time, it is necessary to vary therefrom more or less. Therefore, in order that conditions of this kind can be met it is the practice to put out allowances on a monthly basis.

About the tenth of each month the roadmaster of each division prepares recommendations as to the maintenance work to be done during the following month. These are forwarded to the general superintendent of the grand division. In addition to this form the divisions are required to support their recommendations with an explanatory letter going more into detail as to the expenditures proposed for each item or account. The district engineer on the general superintendent's staff reviews these recommendations and if he considers them conservative they are forwarded to the engineer maintenance of way, who compiles recommendations for the system which are submitted to the management for approval.

Upon receipt of approval of these recommendations from the management, the engineer maintenance of way holds in his office what is termed an expense meeting. These meetings are held in the latter part of the month preceding the month for which the allowance has been

granted, and are attended by the general superintendents and district engineers for their grand divisions and the superintendents and roadmasters for their respective divisions. At such meeting subjects of general interest to all are discussed. Following this, work recommended for the following month on each division is discussed in detail by primary accounts with the general superintendent, district engineer, superintendent and roadmaster, at which time it is agreed what the division allotment will be.

Following this the roadmasters distribute their allotments to their respective supervisors, who in turn distribute their allotments among their regular section and extra gangs. The amount of work allotted by supervisors to their sections is made, as far as practicable, with a view of carrying out work on the respective sections in accordance with the plan which had been previously planned. Efforts in this direction have not met with success in every instance, but the work is being carried on with this end in view and it is felt progress has been made.

Programming Bridge and Structure Maintenance

As far as the heavier and more important work is concerned, it is the fairly common practice on most roads to prepare programs for the repair of bridges, buildings, water stations and other structures. This condition arises from the necessity of inspecting these structures sufficiently in advance of their repair to enable the amount and character of the work to be done to be ascertained and the materials ordered, assembled and delivered at the site of the work prior to the arrival of the gang. For this reason it is the fairly common practice to make a detailed inspection of these structures each fall to determine the work which it will be necessary to do during the coming year.

From the information gained on this inspection, the division and system maintenance officers are enabled to determine the amount and character of the work to be done during the ensuing year and to make up bills of the material required for the various points and the approximate dates at which they should be delivered at those points. This in effect constitutes a program in a measure, although it is not commonly prepared with any degree of definiteness as to the actual date the work should be undertaken or the order in which it shall be prosecuted. In its investigations the committee found one road, however, which carries this program of its bridge and building maintenance to the point where a definite schedule is prepared for each gang preliminary to the ordering of material for use the following season. This railway is the Midland Valley, on which this plan has been in effect for three years.

The adoption of creosoted timber as standard construction on this road for bridge work led to the ordering of timbers for particular structures to permit them to be framed to dimensions before treatment and thereby conserve the benefit of the treatment. From the information secured on its annual inspection, this road prepares a detailed program of the work to be done during the following year. From this, a working schedule is prepared in detail for each of its brige gangs, showing the order of the work which each gang will undertake, the estimated time of arrival at each job and the time required to complete it before proceeding to the next. Following the completion of this working program, an order is placed with the treating plant for the framing and preservation of the timber required for each structure, with the date on which the material for each structure is to be shipped from the plant. The blanket order for the season's timber requirements, which is given to the treating plant in December of each year, shows the number and size of the individual timbers required for each bridge, their destination and the date on which they are to be shipped from the treating plant. While it has been necessary to deviate from this program occasionally to combat floods and meet other emergencies, it has been found possible to adhere to it with surprising accuracy. Thus in September, 1924, the gangs were only two days behind the schedule which had been prepared for them nine months previously.

Conclusions

The orderly prosecution of maintenance of way work throughout the year is essential to its most economical conduct. It is promoted by:

(a) The preparation of a budget of the work to be done during the year and the authorization of this budget for the year, if possible, or quarterly at least, sufficiently in advance of the inauguration of the work to enable materials and men to be collected in an orderly manner.

(b) The equalization of expenditures on roads where it is practical in accordance with the plan authorized by the Interstate Commerce Commission to eliminate the wide fluctuations in expenditures from month to month.

(c) The preparation of a detailed program in which the work authorized is scheduled so that it may be done at the most economical season consistent with the most efficient utilization of forces.

(d) The carrying of this program down to the local divisions and to the individual gangs on those divisions in order to enable the work of these men to be directed to the best advantage.

Discussion

F. N. Crowell (Penna.) Perhaps some are not aware that the Interstate Commerce Commission has been gradually taking away from us the privilege of equalization. If I am correctly informed, the probability is that when the new classification goes into effect we will have no privilege of equalization. We should all tell our executive and accounting officers that we want the privilege of equalization of maintenance and way expenditures.

Chairman Cook: In connection with the first suggestion I am very glad that Mr. Crowell has stressed this point, because the committee has felt, from the standpoint of the engineers, it is very essential that we retain the equalization feature.

E. F. Wendt (Cons. Engr.): I wish to direct attention to what many of you know, that during the past year or two, several thousand pages of testimony have been presented to the Interstate Commerce Commission showing the cost of track laying and surfacing. There is a great difference between the commission's view of valuation and the carrier's as to what constitutes this cost of track laying and surfacing. I think if the plan suggested by this committee is carried out, that the records would then be so complete that there could be no difference of opinion as to what this cost properly is.

Garrett Davis (C. R I. & P.): We are right now contemplating a programming of work, particularly the track work. The committee referrs to the Illinois Central program of work. I recently made some inquiry into the method and found that this road is not programming its track work as I would call it. The foreman makes a report of the work he does, but he doesn't know in advance what he is going to do from a regular defined program. I will suggest what I have in mind. When the distribution is made, I intend to give it to the section foreman and give him a blank form to fill out as to how he proposes to spend it. If it doesn't agree with the road master's ideas, he can go and talk with that man and revise it. But the more you can get that foreman to think what he is going to do next week and how he is going to do it and get his head working on his work, the better results you will get. I am in favor

of programming it, but it has got to be done in a well defined and definite manner.

E. T. Howson (*Railway Age*): Mr. Davis raises a question regarding the accuracy of the report of the committee and its reference to the Illinois Central. I think the report of the committee is correct, and I think Mr. Davis is also correct. The committee's statement was based upon its investigations on certain parts of the system. The plan in effect and described there is not in effect over the entire system, but is on four or five divisions and is being extended to other divisions. Evidently Mr. Davis' investigation was on divisions on which this is not in effect.

[*A motion to accept the conclusions of Appendix B for publication in the Manual was carried.* The committee was dismissed with the thanks of the Association.]

Report on Records and Accounts

Last year the Committee on Records and Accounts presented as information a progress report on cost keeping methods and statistical records in which it outlined a procedure for securing unit costs. This work was continued and in its report this year it submitted a complete analysis of the problem. Three different classifications were discussed as basis for separating the cost figures. These included studies of maintenance costs from I. C. C. primary accounts, from sub-primary accounts and from special studies. The conclusions of the committee were that cost-keeping and statistical records were practical and productive of economies through the facilitated control of expenditures. H. M. Stout has been chairman of this committee for 5 years and a member of it for the last 11 years.

H. M. Stout
Chairman

THE COMMITTEE submitted reports covering the following subjects: (2) Cost-keeping methods and statistical records. The first progress report on this subject, which is a combination of the two subjects in Appendix A; (3) A preliminary report on the plans, methods and forms for gathering and recording data for keeping up to date the physical and valuation records of the property of railways, in an Appendix B; and (7) a progress report on the comparison of daily and monthly time and material reports in an Appendix C. In regard to Subject 6 on the revision of the I. C. C. classifications of accounts, it stated that there was little to be added to the report made to the Association last year. The resolution adopted by the convention in March, 1924, produced no observable effect in the way of increasing the receptivity to the suggestions of the special committee of engineers of the A. R. A. by the Railway Accounting Officers Association.

At the direction of the committe on general accounts of the R. A. O. A. the special committee of accountants which co-operated with the Bureau of Accounts in the preparation of the tentative revision of the classification of operating expenses (draft of November 20, 1923) drew up another revision of the operating expense classification, the submission of which to the director of the Bureau of Accounts, Interstate Commerce Commission, as a progress report was approved at a meeting of the Committee on General Accounts in New York, September 10 and 11, 1924.

Commissioner Eastman of the Interstate Commerce Commission, in a letter to the thirty-sixth annual meeting of the Railway Accounting Officers Association, assembled at San Francisco, July 9, 10 and 11, intimated that cost accounting as a principle was being given consideration in connection with the revision of the operating expense classification.

Progress on the revision of the other classifications by the Interstate Commerce Commission, whatever has been done, has not reached the stage of distribution of tentative drafts.

The committee recommended that Appendix A be received as a final report on the subject of Cost-Keeping Methods and Statistical Records, and that the matter contained in Appendix A, except the appended note on supplementary bibliography, be approved and incorporated in the Manual.

Committee—H. M. Stout (N. P.), chairman; V. R. Walling (C. & W. I.), vice-chairman; E. G. Allen (A. T. & S. F.), A. M. Blanchard (C. N. R.), L. H. Bond (I. C.), *W. A. Brewer (C. & N. W.), Z. M. Briggs (Penna.), George H. Burgess (D. & H.), A. C. Copland (C. & O.), H. C. Crowell (Penna.), E. B. Crane (C. M. & St. P.), L. G. Curtis (B. & O. C. T.), P. O. Ellis (M. K. T.), J. H. Hande (B. & O.), C. C. Haire (I. C.), T. J. Irving (C. & N. W.), F. W. Hillman (C. & N. W.), Henry Lehn (N. Y. C.), H. T. Livingston (C. R. I. & P.), L. P. Rossiter (L. V.), H. J. Sargent (Wab.), H. F. Sharpley (C. of Ga.), C. W. Simpson (D. L. & W.), F. C. Squire (Pres. Conf. Com.), W. A. Van Hook (Ford, Bacon & Davis Co.), G. R. Walsh (M. P.), H. R. Westcott (N. Y. N. H. & H.).

Appendix A—Cost-Keeping Methods, Statistical Records, and Forms for Analyzing Expenditures for Assistance in Controlling Expenditures

In preparing, assembling and making use of data for these purposes certain fundamentals must be observed. It must first be determined in what unit the information is required, such as cost of renewing ties per tie, relaying rail per mile, painting bridges per ton of steel, maintaining roadway and track per equated track mile, etc. An analysis of the accounting and statistical routine should then be made to know that the information required is readily available, and if not in proper form it must be made to fit the requirements. The field data are the foundation of cost-keeping and must be secured in sufficient detail for the purpose and be accurate.

*Died November 30, 1924.

The classification of operating expenses, as prescribed by the Interstate Commerce Commission, was not formulated to show directly unit costs of maintenance and the limitations of the accounting in that respect control the kind of an analysis of maintenance costs that can be made. Further consideration of these matters points out that this study may be resolved into three classifications, as follows: (1) Maintenance costs from primary accounts; (2) Maintenance costs from sub-primary accounts; and (3) Maintenance costs from special cost study.

Maintenance Costs From Primary Accounts

The charges to the Interstate Commerce Commission Primary Accounts as regularly assembled merely give total expenditures to the various accounts and are not prepared to show unit costs of performing any particular branch of the work, but these data may be easily compiled to show unit cost of maintenance of way and structures per equated track mile or similar unit. A form shown as an Exhibit A was designed for assembling the data, all of which is readily available from the carrier's records, and securing such unit costs as can be obtained from this information. Because of the limitations of the accounting, these unit costs will not show cost of individual work but will show unit cost of roadway and track, bridges and structures and miscellaneous, and total cost of maintenance per equated track mile or similar unit.

Summarized, the form will show comparison of expenditures of the principal items of maintenance by months and by years, and will also show the following unit costs per equated track mile for the same periods. Labor costs of maintaining roadway and track (accounts 202 and 220); total cost of maintaining roadway and track; total cost of maintaining buildings and structures; total cost of miscellaneous; total cost of ordinary maintenance of way and structures, and grand total cost of maintenance of way and structures.

Maintenance Costs from Sub-Primary Accounts

A study of the costs of railroad maintenance may be made of any branch of the work by the sub-division of the primary accounts in such manner that the charges are allocated to the subject under consideration so that unit costs for that class of work may be determined. This is necessary because it has been found in making a study of cost-keeping, as applied to railroad maintenance, that the charges to the classification of accounts as now prescribed by the Interstate Commerce Commission do not furnish the information for an analysis of the unit costs of maintenance of roadbed, track and structures. This may be accomplished by assigning sub-accounts to the several classes of work, as:

220-A—Renewing ballast.
220-B—Renewing ties.
220-C—Renewing rail.
220-D—Renewing frogs, switches, crossings, etc.

The sub-division of primary accounts is recommended as good practice, but it must be understood that it involves some additional expense, which expense is justified if the information thus obtained is used in determining and comparing unit costs, and has for its ultimate purpose the economy of maintenance.

Exhibit "A" has been discussed as the base form for making cost studies under classification "Maintenance Costs from Primary Accounts," and it may also be used as the base for making cost studies of individual items of maintenance of a division or road, combined with all the other items of maintenance, so as to secure unit costs of individual work and as a final result obtain the cost of maintenance of way and structures per equated track mile or similar unit. An Exhibit "A" has been designed to show the application of this method of roadway and track. Expenditures are segregated to labor and material. Labor is further segregated to the main items of work, such as reballasting, renewing ties, etc., renewing rail, ditching, care of roadbed, patrolling and watching, etc., with appropriate units for each class of work and with quantities of materials used, thus giving the information for determining unit costs. Expenditures for material are segregated to the appropriate account numbers.

In cost-keeping analyses the generally accepted unit of value is the dollar. The principal objection that may be raised to the use of this unit is the difference in the wage rate per hour in different localities even on the same road for the same class of work. The best unit of measure for labor is undoubtedly the hour, and in studies of efficiency for comparing work performed, hours worked instead of dollars expended would doubtless prove the more satisfactory unit. In studies of this nature, however, it can not be easily combined with money values of material and the dollar unit should be used.

Maintenance Costs from Special Cost Study

Any specific work is made up of a number of operations repeated for each unit of installation; to be certain that the cost of doing the work as a whole is being economically performed the principal individual steps in carrying on the work should be analyzed and costs determined and compared. Without repetition it will be understood that the routine of accounting and gathering of the statistical information, as previously outlined, for handling of special cost studies has already been provided.

There is a large field of cost study in this line, but it is not practical or necessary to give examples of all. Typical subjects have been selected and practically the same method of handling may easily be applied to other subjects. The subjects considered are as follows:

Cost of Renewing Cross-Ties—Exhibit 1

This exhibit showed material cost of tie, train service expense in handling, and detail of labor expense in making the tie renewal with total cost per tie. The cost of renewing switch ties and bridge ties may be shown in like manner.

Cost of Renewing Rail—Exhibit 2

A number of operations are involved in the relaying of rail and the cost of the work will depend to some extent upon how it is handled, that is, if it is laid under traffic, by hand or by machine. Exhibit 2 was designed to show this information, with cost per unit and cost per mile, segregated to labor, work train service and material and combined for total expense.

Cost of Painting Bridges per Ton of Steel and per Square Foot of Surface Area—Exhibit 3

One of the principal items of the cost of maintaining steel bridges is cost of painting. This exhibit was designed to be used for individual bridges, but with slight modifications it may be used for all bridges of a type or for all bridges of a division or system. Similar forms may be prepared to record cost of painting buildings and other maintenance costs where the work is in sufficient volume to justify the record.

Cost of Maintenance and Operating Coaling Stations—Exhibit 4

This exhibit was designed to give comparative data of the cost of maintenance and of operation of coaling stations by years and by types of plant. This form may be subject to criticism because of the inclusion

of cost of operation, but it has been prepared in this manner because there are roads where the management of operation as well as of maintenance rests with the engineering department, and also where it is an engineering duty to investigate cost of operation and to assist in the selection of the proper type of station. The cost of maintaining and operating water stations, cinder pits, etc., may be obtained in like manner.

Statistscal Records

Statistical records of maintenance of way and structures cover a large variety of subjects, and include such items as number of ties renewed, tons of rail laid, cubic yards of ballast placed, man hours worked, etc., and also includes costs of work performed either in unit assigned or in total. Exhibits "A" and "B," while developed for the purpose of illustrating cost-keeping methods, are none the less statistical records which show periodical expenditures to the several sub-divisions of maintenance and unit costs of certain items. Some typical forms for recording statistics in connection with railroad maintenance and for use in the study of maintenance costs were presented as follows:

Hourly Rates of Pay of Trackmen—Exhibit 5

This chart provides for a graphic representation of hourly rates of pay and also the length of the working day. Prior to 1917 there had been but little variation from year to year in these items, but subsequently rates of pay were increased and the working day reduced. In comparing expenditures per unit of work from year to year and making a study of the same, it is necessary that the information as to rates of pay and hours of labor be readily available that a true comparison of the cost per unit may be had. Hourly rates of pay of other classes of labor may be charted on similar forms.

Average Cost of Ties and Rail—Exhibits 6 and 7

These two exhibits show in graphic form a method of recording the average cost of cross-ties and of rail. As additional information, on Exhibit 7, was shown, average cost of relayer and scrap rail.

Comparison of Tie Renewals—Exhibit 8

This chart showed a comparison of tie renewals, estimated and actual, from the year 1900 to and including the current year. The chart also shows number of ties in track on sub-division, division or road, with annual renewals to be made, based on varying lengths of life of ties from 5 to 20 years. The actual average life of ties in track is also shown. The method used for determining this for any year is to ascertain the number of prior years required to accumulate total renewals equal to the average number of ties in track on the section of track under consideration. This chart will show the trend of longer life of tie, due to greater use of treated ties and tie plates.

Rail in Track and Rail Renewals—Exhibit 9

This chart shows in statement form rail in track—both gross tons and track miles, also rail renewals in gross tons, track miles and in track miles per cent. Renewals in track miles is shown graphically. This unit is chosen rather than gross tons, as it is believed it will more accurately represent comparison by years.

Graphical Comparison of Hours of Labor Worked—Exhibits 10, 11 and 12

Exhibits 10 and 11 show total labor worked in the several sub-divisions of maintenance of way and structures; the former gives comparison by months for the three preceding years, thus showing the seasonal variation, while the latter gives comparisons by years. Exhibit 12 gives comparison of total hours of labor worked maintaining roadbed and track per road mile, track mile and equated mile. If the amount of work to be done yearly were constant, this form would show the relative efficiency of labor and supervision. Allowance, however, may be made for this variation and the chart should be of value in assisting in the control of expenditures.

Graphical Comparison of Expenditures—Exhibits 13, 14 and 15

Exhibit 13 shows comparison of total expenditures by years for maintenance of way and structures, and sub-divided into roadway and track, bridges and buildings, signals and electrical and "all others." Exhibit 14 gives comparison of total cost of maintaining roadbed and track per road mile, track mile and equated track mile. These two forms are the same as Exhibits 11 and 12, except that while expenditures are charted on these, hours of labor are charted on them. Exhibit 15 shows comparison by years for expenditures per 1,000,000 gross and net ton miles.

Forms for Analyzing Expenditures for Assistance in Controlling Expenditures

Control of expenditures is the regulation of expenses and in its larger sense is a function of management. When revenues are not produced as anticipated the management, mindful of its duty to the public for service and to the lenders of capital for their charges, is confronted with the problem of reducing the expenditures to meet the necessities of the case. The practical method of doing this is to allot stipulated amounts for expenditures for certain divisions of work for designated periods, with the responsibility of the proper distribution of the allotment left to those more directly in charge. Two exhibits were presented by the committee showing control of expenditures by fixed amounts.

Conclusions

(1) The classification of operating expenses, as prescribed by the Interstate Commerce Commission, is not formulated to show directly unit costs of any item of maintenance of way and structures, but these data can be compiled to show unit cost of maintenance per equated track mile or similar unit.

(2) Unit costs of the main items of maintenance, particularly those pertaining to roadway and track, may be determined by sub-division of the primary accounts in such manner that the charges are allocated to those items. This sub-division of primary accounts involves some additional expense, which is well justified when the information thus obtained is used in determining and comparing unit costs, and is recommended as good practice.

(3 Analysis of the costs of the details of any item of maintenance can not be made from the primary accounts or sub-divisions of primary accounts, but they may be obtained in the manner desired through special study of that subject.

(4) Cost-keeping and statistical records, applied to expenditures for maintenance of way and structures, as indicated in this report, is a practical matter. Through their application expenses may be analyzed, economies of maintenance brought about and control of expenditures facilitated.

Discussion

Chairman H. M. Stout presented the report in Appendix A and *moved its adoption for inclusion in the Manual.*

H. M. Lull (S. P.): If the forms and methods of analyses of expense could be put into effect to the extent recom-

mended it would be of great assistance to every one who has to look after the expenditure of money allowed or be more or less responsible for the conduct of the work. However, it seems to me that on some railroads, at least, it would be rather a difficult matter to handle in the manner recommended. The Interstate Commerce Commission prescribes certain forms and methods of keeping railroad accounts and the general auditors of most railroads are rather jealous of their prerogatives with respect to being responsible for all the accounting done on the railroads. I don't see anything in this report recommending how these accounts are to be kept.

W. R. Walling (C. & W. I.): What the committee has suggested in the sub-primary accounts, the division of the accounts, i.e., breaking them up into diffierent subdivisions, is a practice that is now being used on a number of roads. There is nothing that I know of which the Interstate Commerce Commission would take exception to, because the total of the accounts in the last analysis goes to the proper primary account. How they are handled by the accounting department or the engineering accounting department is a detail which would be developed by the individual road according to their practice.

Mr. Lull: Would the committee care to express their own opinion as to what is the best method of handling the detail?

Mr. Walling: That particular phase of the matter was not discussed by the committee to any extent, simply because the procedure on the different roads should determine how they would continue to handle it, and any road that saw fit to set up sub-primary accounts could probably secure that from some of the roads that have already pioneered in it.

(*Motion carried*).

(The committee was dismissed with the thanks of the Association.)

Report on Signs, Fences and Crossings

The Committee on Signs, Fences and Crossings resubmitted its recommendation for a revision of Section 2 of the specifications for highway crossings in the Manual which elicited considerable discussion last year at the convention. It presented definitions of bituminous materials and specifications for bituminous crossings for approval and publication in the Manual and submitted a progress report on the elimination of highway grade crossings. Information was compiled outlining the methods followed by the various states in apportioning the cost of highway improvements adjacent and parallel to railroad rights-of-way. A progress report was presented on improved methods of preventing corrosion of fence wire. T. E. Rust is chairman of this committee for the first time.

T. E. Rust
Chairman

THE COMMITTEE presented a report covering (1) Revision of the Manual (Appendix A); (2) The various substitutes for wooden crossing planks for the crossing of highways and city streets, with specifications for bituminous crossings (Appendix B); (3) Methods of apportioning the cost of street and highway improvements adjacent and parallel to railroad rights-of-way (Appendix C); (4-a) The elimination of highway grade crossings (Appendix D); (4-b) The elimination of highway grade crossings (Appendix E); (5) Plans for end, corner and gate posts of concrete and a method of bracing the same (Appendix F), and (6) Improved methods of preventing corrosion of fence wire (Appendix G).

The action recommended was that the change in the Manual in Appendix A be approved and the revised version substituted for the present recommendation in the Manual; and that the definitions of Bituminous Materials and Specifications for Bituminous Crossings in Appendix B be approved for publication in the Manual.

Committee: T. E. Rust (W. C. F. & N.), Chairman; A. B. Griggs (A. T. & S. F.), Vice Chairman; Anton Anderson (C. I. & L.), Arthur Anderson (N. Y. C.), F. D. Batchellor (B. & O.), R. E. Chamberlain (B. & O.), W. E. Colladay (I. C.), A. Crumpton (C. N. R.), L. B. Curtiss (N. P.), R. L. Dyke (Erie), G. N. Edmondson (N. Y. C.), F. M. Graham (Penna.), A. C. Harvey (N. Y. C. & St. L.), W. O. Houston (M. C.), Maro Johnson (I. C.), E. T. Johnston (Erie), S. C. Jump (I. C.), E. R. Lewis (M. C.), F. J. Nannah (P. & L. E.), G. H. Smith (N. Y. C.), T. H. Strate (C. M. & St. P.), H. Stringfellow (U. S. R. R. Administration), W. C. Swartout (M. P.), M. D. Thompson (I. C.), A. H. Utter (C. B. & Q.).

Appendix A—Revision of the Manual

Present Form	Proposed Form
Sec. 2. "Where the topography is favorable the grade of the surface of the highway should be level with the top of the near rail for a distance of 1 ft. outside thereof; should be 3 in. lower 10 ft. outside of the rail, and should be not more than 3 in. higher nor 9 in. lower than the top of the rail at points 30 ft. from it measured at right angles thereto. The grade beyond these 30 ft. points should not exceed that which prevails in that section of the country for highways of the class under consideration."	"The grade of the surface of the highway should be level with the top of the near rail for a distance of 1 ft. outside thereof," etc.

Appendix B—Specifications for Bituminous Crossings and Substitutes for Wooden Crossing Plank

Last year the committee prepared, and presented as information, specifications for the construction of bituminous crossings. This year these specifications were reviewed and amended and were recommended for ap-

proval and publication in the Manual. To some extent bituminous crossings are still in the experimental stage so that any specifications adopted now may, perhaps, require revision from time to time. The committee believes, however, that knowledge of the subject is sufficiently advanced to warrant the adoption of these specifications.

The committee was unable to agree on the subject of flangeways and the use of wooden or metal flange guards is, therefore, left optional. Some roads find the use of flange guards necessary and others seem to get better results when the wheels are allowed to roll their own flangeways. Climatic conditions, local variations in construction methods and differences in the character of highway travel may account for the varying results obtained.

Definitions of Bituminous Materials

Last year, definitions of bituminous materials were prepared, being, in general, abbreviations or copies of the definitions gotten out by the American Society for Testing Materials. These definitions appear on pages 624 and 625 of Vol. 25 of the Proceedings. It is recommended that they be adopted for publication in the Manual as being necessary for a correct understanding of the Specifications for Bituminous Crossings.

Specifications for the Construction of Bituminous Crossings

1. General.—These specifications cover the use of emulsified asphalt, rock asphalt and cut-back products in the construction of bituminous crossings. They must be carried out in detail and with good workmanship.

2. Foundation.—All the old ballast shall be removed for the full width of the crossing between lines not less than two feet outside each rail and replaced with new ballast consisting of clean crushed stone having a depth of not less than six inches below the bottom of the tie.

All ties not in good condition shall be removed and replaced with new ties (preferably treated ties) and fitted with tie plates. All badly worn track material shall be replaced with new material, eliminating rail joints if practicable.

Provision shall be made for draining the roadbed. The track shall be carefully lined and surfaced. The new ballast shall be thoroughly tamped to form an unyielding foundation, the surface of which, after being tamped, shall be four inches below top of rail for a crossing where an emulsified material is used; three inches where a cut-back material is used, and one and one-half inches where rock asphalt is used. Where the crossing is to be constructed of rock asphalt the voids in the stone ballast above top of tie shall be filled with limestone screenings sprinkled with water and tamped to form a solid, water-bound pavement which shall be allowed to dry before the rock asphalt is applied.

The new stone ballast shall conform to the American Railway Engineering Association specifications for stone ballast.

3. Handling Materials.—Bitumens shall be thoroughly mixed before removal from the barrel.

Emulsified asphalt shall not be exposed to freezing temperatures.

Cut-back products contain an inflammable solvent and care should be taken to keep them away from open flames.

Concrete in which a cut-back mixture is used shall be made and stored at least five days before using. It shall be left uncovered to permit curing but shall be protected from rain.

Rock asphalt shall not be laid on or spread when the temperature is below fifty degrees F., nor on a damp foundation.

4-A. Method of Constructing Pavement.—When an emulsified asphalt is used as the cementing agent, the following paragraphs shall govern:

Binder Course.—Upon the foundation of ballast there shall be spread evenly a layer of bituminous concrete which, after being thoroughly tamped, shall be two and one-half inches thick with top surface one and one-half inches below top of rail. It shall be made in the following proportions:

1 cu. ft. clean ballast stone.
1/3 to ½ gal. of bitumen.

The concrete shall be thoroughly mixed and the stone uniformly coated with the bitumen. This can be done by placing the stone on a mixing board in a layer about six inches deep, adding the bitumen, and then raking or turning over the mixture with shovels.

Wearing Surface.—Upon the binder course there shall be spread evenly a layer of bituminous concrete which shall be thoroughly tamped, preferably with a self-propelled roller. When such a roller is used, the finished surface, after rolling, shall be level with the top of rail but not crowned. When tamped by hand or with a hand roller, the finished surface shall be from one-half to one inch above the top of rail to allow for compacting by vehicles. The concrete shall be made on a mixing board in the same manner as the binder course and in the following proportions:

1 cu. ft. ¾ in. clean stone.
1 gal. of bitumen.

Seal Coat.—A seal coat of clean sand mixed with bitumen shall be spread over the crossing to fill the voids but not to make a layer. It shall be made in the following proportions:

1 cu. ft. wet sand.
1½ gal. of bitumen.

Flangeways.—Particular attention shall be given to thoroughly compacting the bituminous concrete adjoining wood or steel flange guards or rail heads. Where wood or steel flange guards are not provided and flangeways are cut by trains passing over the crossing, they shall be sealed by applying to the grooves a solution of two parts bitumen and one part water.

4-B. Method of Constructing Pavement.—If a cut-back product is used as the cementing agent the following paragraphs shall govern:

Wearing Surface.—Upon the foundation of ballast there shall be spread evenly a layer of bituminous concrete which shall be thoroughly tamped, preferably with a self-propelled roller. When such a roller is used the finished surface, after rolling, shall be not less than three inches thick and level with the top of rail, but not crowned. When tamped by hand or with a hand roller, the finished surface shall be from one-half inch to one inch above the top of rail to allow for compacting by vehicles. The concrete shall be made in the following proportions:

1 cu. ft. ¾ in. clean stone.
1/3 cu. ft. sand.
2/3 gal. bitumen.

The concrete shall be thoroughly mixed and the stone uniformly coated with the bitumen. This can be done by placing the aggregate on a mixing board in a layer about six inches deep, adding the bitumen, and then raking or turning over the mixture with shovels.

Seal Coat.—A seal coat of one-quarter inch stone, pea gravel, or coarse sand shall be spread or crushed evenly over the crossing but only in sufficient quantity to fill the surface voids. It shall be made in the following proportions:

1 cu. ft. of aggregate.
1½ gal. of bitumen.

Flangeways.—Particular attention shall be given to thoroughly compacting the bituminous concrete adjoining wood or steel flange guards or rail heads.

4-C. Method of Constructing Pavement.—If a rock asphalt is used, the following paragraphs shall govern:

Wearing Surface.—The rock asphalt shall be shoveled into place on the foundation and raked thoroughly to produce an even surface and even thickness of two and one-quarter inches. After raking, the rock asphalt shall lie until the sun and heat of the air begin to bring an oily appearance to the surface. It shall then be tamped or, perferably, rolled with a self-propelled roller until the entire surface is smooth and free from waves, depressions or honey-combed areas, until all roller or tamping marks disappear, and until the finished surface is level with the top of rail.

Flangeways.—Particular attention shall be given to thoroughly compacting the rock asphalt adjoining wood or metal flange guards or rail heads.

5. Repairs.—Holes or pockets in the pavement shall be repaired as soon as they appear and a small quantity of material shall be stored properly, near the crossing, for this purpose.

Appendix D—Elimination of Highway Grade Crossings

Necessity for the Improvement

Character of the Railroad.—The first general consideration as to the necessity for the improvement is the character of the railroad involved. In the case of a main line, the number of tracks and their relation one to the other in arrangement, whether immediately parallel or separated; on the same grade or different grades, are factors to be considered. Branch lines, except in cities, will usually have but one track.

The number of trains per day and their speed is of importance in determining the necessity for the improvement, and also the time of day at which high speed trains

may be scheduled to pass, traffic on the highway being usually heavier during the daylight and early evening hours and lighter after midnight and during the early morning hours.

The topography of the location and its influence on range of vision and gradients, the feasibility of eliminating the crossing by relocation, and the possibility of affording adequate protection by means other than grade separation, are factors which merit consideration.

Character of the Highway.—Density of traffic on the highway is one of the most important considerations in determining the necessity for the improvement. The trunk line hard surfaced rural highways are fast becoming the main arteries of motor vehicle travel and are approaching the importance of city streets. The interruption of the steady flow of vehicle traffic by passing trains congests this traffic and increases the danger of accidents, particularly on rail lines of two or more tracks. For both rural and city crossings the density of traffic is to be determined by a traffic count which shall be taken by hours for twenty-four hour periods for seven consecutive days and shall show, separately, the number of vehicles, pedestrians and trains in such detail as may seem desirable. Weather conditions shall be noted. Important conclusions can be drawn from an analysis of the information so gathered.

Existing approach grades on the highway, in so far as they limit traffic or increase hazard should be considered.

The angle of an existing crossing is an element to be considered in determining the necessity for grade separation, since the more acute the angle, the more hazardous the crossing.

The range of vision and the character and adequacy of the existing protection, if any, are also to be considered.

Benefits Derived

By the Railroad.—The most important benefits derived by the railroad through grade separation are the elimination of hazard and of damage claims.

At crossings where the speed of trains is now reduced, grade separation will be of advantage to the railroad in eliminating such delays.

The separation of grades will effect the following operating economies:

Reduced fuel consumption at crossings where trains previously reduced speed.
Expense of gates, watchman and other existing protection.
Maintenance of crossing paving and cattle guards.
Reduced track maintenance.

By the Public—From the standpoint of the public, the most important benefits of grade separation are the elimination of hazard and the speeding up of highway traffic.

Another benefit is an increase in the capacity of the crossing and, in some cases, a reduction in the traffic over adjacent grade crossings. The benefits of elimination of hazard and speeding up of traffic may, therefore, extend not only to the traffic formerly carried by the crossing in question but to a considerable part of that carried by other crossings nearby.

Objections

By the Railroad Due to Increase in Grades—Grade separation necessitating additional rise and fall or an increase in the rate of railway grades may involve a permanent increase in the cost of operation, and, therefore, any increase in the rate of grade should be reduced to a minimum and grade changes which would result in a reduction of train tonnage should not be made. There are, however, instances where an increase in the rate of existing grades may not be objectionable from an operating standpoint. Where the railroad is elevated and a station stop is located on the elevation there would be no serious objection to an increase in the approach grades if they do not exceed the ruling grade.

In general the elevation of the steam line tracks has less objectionable features than their depression for the reason that the required clearances are less. Overhead clearances for highways range from 12 ft. to 18 ft., depending on the character of the highway and whether electric cars have to be provided for. When the steam line tracks are depressed the desired overhead clearance from top of rail is 22½ ft., and in many states and in all of Canada this minimum is specified by law.

Partial depression of the steam line and partial elevation of the highway is often employed to restrict changes in grade, the separation projects in Detroit and Kansas City being notable examples.

For rural grade separation the overhead highway plan is usually employed because the advantages of topography can be employed in the relocation of highways, and because the erection of highway bridges can be made at an expense not to be approached in the construction of structures to carry railroad tracks.

By the Railroad on Account of Industry Track Connections—Where a grade separation project involves an industrial district, one of the principal objections to the project from the railroad standpoint is the difficulty and expense of connecting up the industry tracks to the elevated or depressed main tracks. In this case the approach railroad grades are usually of minor importance. In general there will be but two approaches, one entering the district and one leaving.

Approach grades from an elevated main line are usually accomplished at less expense than from a depressed main line, the latter often involving the use of retaining walls at right-of-way limits.

By the Railroad on Account of Restricted Expansion—Any separation of the main line grade from that of contiguous territory is objectionable in that it limits the opportunity for expansion. In undertaking such projects the probable requirements of the future should be given much consideration. Necessary right-of-way for contemplated future tracks should be provided and the grade seperation structure designed to take care of future requirements.

In general, the elevation of the main tracks is less objectionable than depression and future expansion will be less expensive to accomplish. Drainage problems will be more easily handled and there will be less disturbance of exisiting improvements.

Appendix E—Elimination of Highway Grade Crossings

General Plans

[Owing to the large overlap in the matter presented in Appendices D and E material in Appendix E which covers the same ground as in Appendix D has been omitted. —Editor.]

It is desirable that adequate surveys be made for every grade separation project, well in advance of consideration of an actual program of construction, in order that the problem may be presented in definite terms; which presentation is only feasible after thorough study of plans prepared from data obtained by engineers employing the instruments and methods of precision peculiar to the profession.

From the standpoint of elimination as against construction of grade separations, the possibility of relocation of highways, and sometimes railroad tracks, become attractive and worthy of serious consideration even in the face of seemingly insurmountable obstacles and the long negotiations so frequently necessary with the various public bodies and authorities interested. Highways and street car lines which cross and recross a line of steam railroad in rural districts may sometimes be relocated

at much less expense than grade separations can be built on existing locations. It is suggested that steam railroad companies make intensive investigations of all such possibilities along their lines without delay; entering into suitable negotiations with highway authorities with a view to minimizing the necessity for future grade separation and thus forestalling the improvement of these lesser lines of traffic on existing undesirable locations.

Discussion

[The report was presented by J. E. Rust, chairman, who *moved that the revision of the Manual as recommended by the committee be adopted. Motion carried.* Chairman Rust also submitted the report in Appendix B, on specifications for bituminous crossings and *moved that the specifications be approved for publication in the Manual. The motion was carried.*]

R. H. Ford (C., R. I. & P.): I confess to a feeling of almost amazement in reading the two reports (Appendices D and E), and what I have to say now I hope the committee will feel is intended for constructive criticism. I consider that this committee in place of looking at this problem purely from the economic standpoint, has gone to work and treated this problem purely from a construction standpoint, and I don't think they have done a very good job at that. I don't think that this committee has any place in considering plans for separation of grades. I think their province is purely and simply to see what they can do to enable the railroads to educate the public and work through the association to avoid these unnecessary separations. I hope that it will take these reports and come back next year with a constructive report based upon sound economics.

Chairman Rust: While I agree, of course, as we all do, with a great deal that Mr. Ford has said, your committee was not asked to report on methods of protecting grade crossings, or on methods of preventing grade separation. It was given the subject of grade separation, and understood that assignment to mean that it was to assist the engineer on the railroad who is confronted with specific grade separation problems.

President Ray: In dismissing this committee, the Chair would like to make just one statement in regard to the discussion that has just taken place. Personally, I should dislike to have the impression go out from this association that it is unwise to take the public into our confidence in regard to any of our work. We have lots of difficulties and have had in the past, but it has been my experience that the best and safest way in the long run is to take the public into your confidence in every problem that you are up against. There are lots of cases where we can eliminate dangerous conditions without unnecessary expenditures by getting the authorities who have the changing of highways and the altering of the conditions along and near our crossings under their control, to go along with us on reasonable and sensible methods of eliminating crossings and eliminating dangers at minor expenditures.

(The committee was dismissed with the thanks of the association.)

Report of the Committee on Track

The Committee on Track presented for revision of the Manual an amended table for temperature expansion for laying rail which gives values for 39 ft. and 45 ft. rails, and submitted for adoption detail plans of certain types of crossings, compromise joints and compromise rails. As a result of its investigations it recommended the canting of rail inwardly at the rate of 1 in 20. The reconditioning of rail for relaying and the building up of battered ends in the track is a subject of great importance regarding which the committee has given figures showing comparative costs of re-sawing, re-rolling and building up rail ends by the oxy-acetylene process. Data on track construction in city streets was also included. W. P. Wiltsee has been chairman of the committee for 7 years and a member for 9 years.

W. P. Wiltsee
Chairman

THE COMMITTEE presented a report on (1) Revision of the Manual (Appendix A), (2) Detail Plans of Switches and Frogs, Crossings, etc. (Appendix B), (5) The Canting of Rail Inward and the Taper of the Tread of Wheels (Appendix C.), (7) The Resawing and Reconditioning of Rails for Relaying and the Building Up of Battered Rail Ends in the Track (Appendix D), and (10) Track Construction in Paved Streets and Highways (Appendix E).

The action recommended was that the changes in the Manual in Appendix A be approved and the revised version substituted for the present recommendations in the Manual; that certain plans and specifications in Appendix B be adopted as recommended practice and published in the Manual; and that certain plans in Appendix B be accepted as information, and that the conclusions in Appendix C be received as information and those in Appendices D and E be approved for publication as recommended in the individual reports.

Committee: W. P. Wiltsee (N. & W.), chairman; J. V. Neubert (N. Y. C.), vice-chairman; L. B. Allen (C. & O.), V. Angerer (Wm. Wharton, Jr., & Co.), J. B. Baker (Penna.), S. Balkwill (Balkwill Mang. Crossing Co.), C. W. Breed (C. B. & Q.), H. W. Brown (F. E. Co.), W. T. Brown (F. E. C.), H. G. Clark (C. R. I. & P.), J. W. De Moyer (A. C.), L. W. Deslauriers (C. P. R.), C. R. Harding (S. P.), W. J. Harris (C. B. & Q.), O. F. Harting (T. R. R. A.), T. T. Irving (C. N. R.), H. D. Knecht (M. P.), E. R. Lewis (M. C.), R. L. Longshore (Wabash), J. De N. Macomb (A. T. & S. F.), F. H. Masters (E. J. & E.), C. E. Merwin (D. T.), W. W. Morrison (P. & S.), J. B. Myers (B. & O.), W. G. Nusz (I. C.), E. W. Oliver (C. N. R.), G. A. Peabody (Cleveland Frog & Crossing Co.), W. H. Petersen

(C. R. I. & P.), I. H. Schram (Erie), G. J. Slibeck (Pettibone, Milliken & Co.), J. B. Strong (Ramapo-Ajax Corp.), E. D. Swift (B. R. of C.), J. R. Watt (L. & N.).

Appendix A—Revision of Manual

The committee recommended the following changes in the Manual and to adopted plans:

Adopt for information only the following subject-matter and table having reference to Temperature Expansion for Laying Rails.

Temperature Expansion for Laying Rails

When laying rails their temperature should be taken by applying a thermometer. To allow for expansion, openings between the ends of rails should be as follows:

Temperature of Rail—Deg. F.	160 Jts. Per Mile 33-ft. Rails	135 Jts. Per Mile 39-ft. Rails	117 Jts. Per Mile 45-ft. Rails
—20 to 0 deg.	5/16 in.	3/8 in.	7/16 in.
0 to 25 deg.	1/4 in.	9/32 in.	11/32 in.
25 to 50 deg.	3/16 in.	7/32 in.	1/4 in.
50 to 75 deg.	1/8 in	5/32 in.	5/32 in.
75 to 100 deg.	1/16 in.	1/16 in.	1/16 in.
Over 100 deg.	Laid Close	Laid Close	Laid Close

Explanation—Above subject-matter and table are the same as in the Manual except include 39-ft. and 45-ft. rails.

Revise specifications for Switches, Frogs, Crossings and Guard Rails, adopted March, 1921, printed on pages 214-220, 1921 Manual, as follows:

Last sentence in section 39, Rivets, page 219, reading "Countersunk rivets shall be flush with the surface and fill the countersink," to read:

"Countersunk rivets shall be flush with the surface and fill the countersink, except that rivets through base and tie plates may have a crown of not more than 1/8 in. below the lower surface of the plate."

Revise plans No. 602 and No. 603, adopted March, 1920, of No. 7 and No. 8 Railbound Manganese Steel Frogs, as follows:

Change bolt spacing in heel extension to read: 5-5-6-5 in. instead of 5-5-5½-5½ in.

Also change the 2½ in. dimension to 2 in. in partial plan view in lower right hand corner of plan just to the left of the title.

Revise plans of:

Bolted Rigid Frogs, adopted March, 1920—Nos. 301, 302, 303, 304, 306 and 307.

Clamp Frogs, adopted March, 1921—Nos. 331, 332, 333 and 334.

Spring Rail Frogs, adopted March, 1920—Nos. 401, 402, 403.

Spring Rail Frogs, adopted March, 1924—No. 404.

Railbound Manganese Steel Frogs, adopted March, 1920—Nos. 601, 602, 603, 604, 605, 606 and 607.

Change foot guard note under specifications reading, "Additional foot guards to be furnished when so specified," to read:

"Additional foot guarding to that shown in plan view to be furnished when so specified."

Appendix B—Detail Plans of Switches and Frogs, Crossings and Double Slip Switches

Plans of Bolted Rail Crossings, Steam Railroad Over Electric Railway, No. 716, angles 90 to 50 deg., inclusive, and No. 717, angles below 50 to 30 deg., inclusive, are offered for adoption as recommended practice.

Plan of Solid Manganese Steel Crossings, angles below 40 to 30 deg., inclusive, No. 773, is offered for adoption as recommended practice.

Plan No. 771-B, showing alternate designs No. 2 and No. 3 for solid manganese steel crossings, angles 90 to 60 deg., inclusive, is offered for information to invite criticism.

Plans No. 700-B, compromise joints, and No. 700-C, compromise rails are offered for adoption as recommended practice.

Plan No. 213, Details for Split Switch Point Derail, is offered as information to invite criticism.

Plan No. 890, diagram of Double Slip Switch showing Names of Parts, is offered for adoption as recommended practice. This plan was prepared in line with standard plans No. 190, 191, 390, 391, 490, 590, 690, 691, giving names of parts of other fixtures.

Plan No. 309, presented as information March, 1921, shows 5 in. dimensions between the two bolts through the heel riser block. This dimension should be omitted, as it should, properly, vary with rails of different width heads. This plan having been received as information only the correction need not be made in the Manual; but reference should be made to the correction as a supplement to the plan.

Reference should also be made to recommended change in the foot guard note under specifications, to read: "Additional foot guarding to that shown in plan view to be furnished when so specified." This change also applies to plan No. 608, received as information March, 1921.

Conclusions

The committee recommends that the following plans be adopted as recommended practice and printed in the Manual:

No. 716, dated Nov., 1924, Bolted Rail Crossings, steam railroad over electric railway, angles 90 to 50 deg., inclusive.

No. 717, dated Nov., 1924, Bolted Rail Crossings, steam railroad over electric railway, angles below 50 to 30 deg., inclusive.

No. 773, dated Nov., 1924, Solid Manganese Steel Crossings, angles below 40 to 30 deg., inclusive.

No. 700-B, dated Nov., 1924, Compromise Joints.

No. 700-C, dated Nov., 1924, Compromise Rails.

No. 890, dated Nov., 1924, Diagram of Double Slip Switch showing names of parts.

The committee also offers for information to invite criticism the following plans:

No. 771-B, dated Nov., 1924, Solid Manganese Steel Crossing, angles 90 to 60 deg., inclusive, Design No. 2 and Design No. 3, alternates for design detailed on Plan No. 771.

No. 213, dated Nov., 194, Details for Split Switch Point Derail.

Appendix C—Canting of the Rail Inward and Taper of Tread of Wheel

A questionnaire was prepared and sent out to determine the current practice in regard to the canting of rail. Sixty-seven railroads replied and their replies are summarized as follows:

1. Of the 67 roads, 33 are canting rail as standard and 14 are canting rail experimentally.

2. The practice of canting rail is gaining favor. 11 roads have adopted canting as standard within the last three years. 22 roads have been canting as standard four years to nineteen years.

3. Practice differs as to the amount of cant. 30 out of 47 replies indicate 1 in 20. 17 replies indicate approximately 1 in 40. 3 replies indicate approximately 1 in 80.

4. The advantages derived from canting rail indicated in the replies to the questionnaire are:

Maintains gauge	28 replies
More uniform wear of head of rail	19 replies
Central loading of rail head	15 replies
Full bearing of wheel on rail head	13 replies
Increases life of rail	10 replies
Prevents tie cutting	7 replies
Increases life of ties	5 replies
More economical design of the plates	5 replies
Reduces flange wear on curves	3 replies
Causes less wear on wheels	2 replies
May tend to reduce transverse fissures	1 reply

5. No special provisions through switches are necessary when canting rail except to bring rails gradually to a vertical position by adzing.

6. Those who have canted rail have had no difficulty through switches except one reply indicating trouble with switch braces backing over shoulder of tie plate.

7. Except in a few instances canting is accomplished by the use of inclined plates. A few roads adze the ties to produce the desired cant of rail.

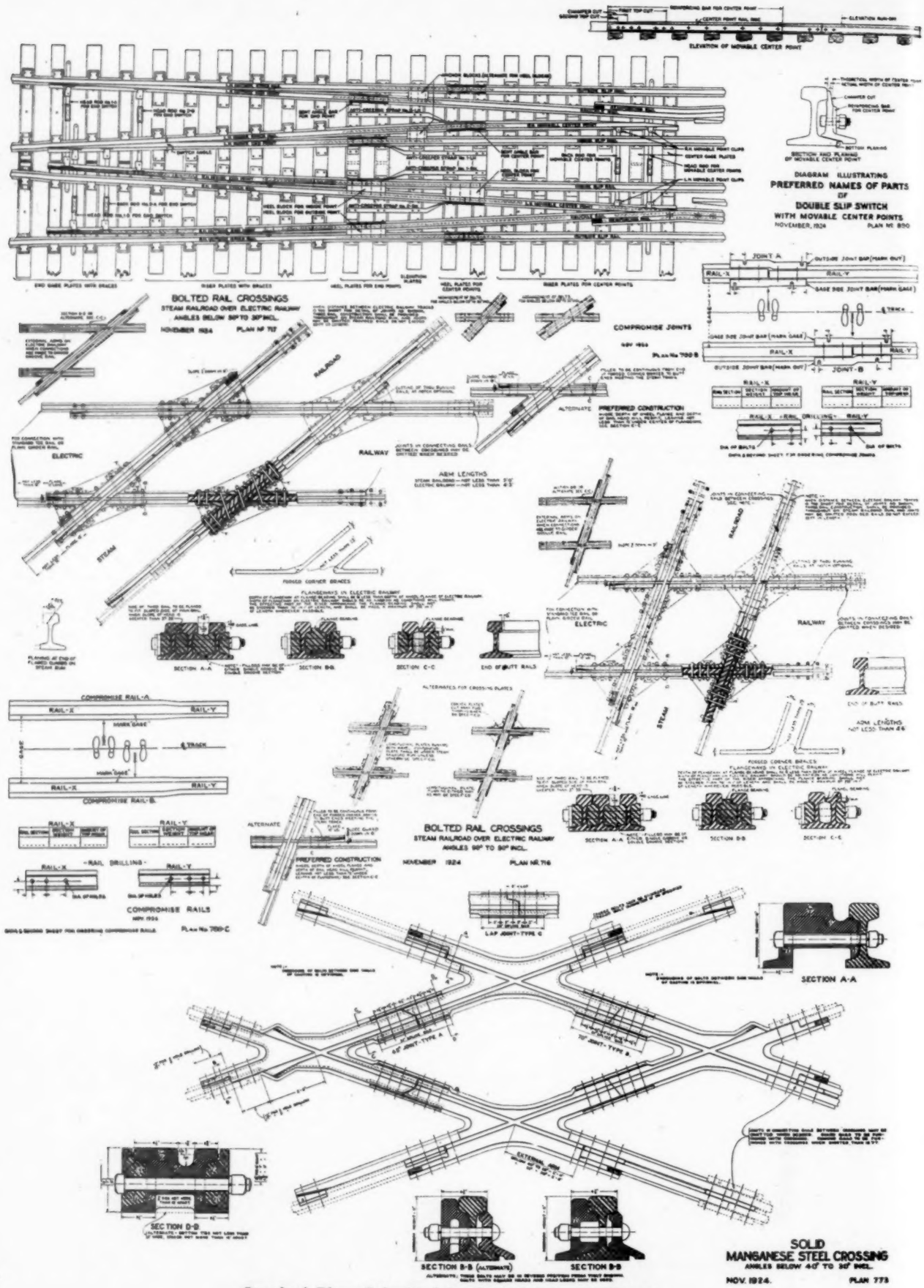
8. The committee endorses the conclusions of the committee on Stresses in Track, after conference with that committee, that:

   (a) Canting the rail inward reduces the lateral bending stresses in the rail for both tangent and curved track.

   (b) Canting the rail inward causes a more central contact of wheel on rail.

   (c) The most benefit is obtained from a cant of 1 in 20.

9. The Mechanical Division—American Railway Associa-



Standard Plans Submitted for Inclusion in the Manual

tion, at its convention, June, 1923, adopted a report against change of the present standard wheel taper of 1 in 20. This report was written by the Committee on Wheels after conference with this committee.

Recommendations

1. Rail should be canted inwardly.
2. Inclined tie plates should be used to produce the desired cant.
3. Amount of cant should be 1 in 20.

Appendix D—Re-Sawing and Re-Conditioning of Rails for Re-Laying and the Building Up of Battered Rail Ends in the Track

There are three methods of reconditioning rail for relaying in main tracks: (1) Resawing rail; (2) rerolling rail; (3) building up the joints and other portions of the rail with electric or oxy-acetylene processes.

The efforts of the sub-committee were directed toward securing the relative economies of the three processes, as well as obtaining definite information for a final report as to the desirability of the various methods.

Resawing Rail

The reconditioning of rail by resawing is the practice on 24 railroads, having a mileage of 153,395 miles, which railroads resaw annually approximately 200,000 tons of rail at an average cost, excluding transportation, of $1.79 per ton. The average transportation cost is given at $1.84 per ton, making total cost, including transportation, $3.63 per ton. This practice is on the increase. In 1923, 128,131 miles of railroad followed this practice and resawed 144,545 tons of rail.

The opinion of all railroads is that this practice is generally satisfactory. Practically all lines use new angle bars when relaying resawed rail. Practically all railroads saw this rail in company mills. Some few of them contract the work to outside parties, but generally the expense of contracting this work is somewhat greater than that done at company mills.

It may be said that practically all railroads report that little consideration has been given to the cost of transporting rail to the rail mills, but that they were entirely controlled by the necessity of renewing the rail that was to be sawed and applying the resawed rail at other points where the rail needed renewal.

Where rail is to be relaid at the same location from which it is removed, portable rail saws have been supplied to saw the rail immediately adjacent to the track, thus eliminating transportation charges, and the expense of resawing the rail is not materially greater than at the rail mill. It also has the added value of securing a better fit at the joint than when the rail is sawed at the mill and indiscriminately relaid in the track. This method of resawing rail should rapidly increase where conditions warrant.

Rerolling Rail

This is a practice on but few railroads at the present time, owing to its cost, which, due to the small quantity of rail rerolled, averages $14.66 per ton, including transportation. It is felt that with the present necessity of renewing rail of the 100-lb. section or greater weights, there will be an added impetus to reroll these heavier sections, where the loss in weight due to rerolling will still leave a heavy section of rail. This increase in quantity available for rerolling will necessarily decrease the cost per ton and will therefore result in a gradual increase in the rerolling of rail for relaying. It is a desirable practice where the condition justifies the cost.

Re-Conditioning Rail by Building Up Battered Ends in Track

Reconditioning rails by building up the battered ends with oxy-acetylene process is a practice on 29 railroads, with a total mileage of 144,350 miles—598,231 joints having been built up by this process at an average cost of $1.58 per joint, or, as near as may be estimated, at an approximate cost of $3.59 per ton.

This method of reconditioning rail is rapidly increasing—the mileage of all roads using this process increasing from a total of 83,000 miles in 1923 to 144,000 in 1924.

The expense of doing this work is controlled by the condition of the rail. The practice would be much more economical if the work was done before the dip in the rail at the joint became too great, and it is generally more economical than resawing rail because it eliminates the loss due to cut-offs, transportation charges, and decreases the number of joints in the track; the work is also done without traffic interruption, which necessarily results when resawing rail.

The results indicate that if careful attention is given to the renewal of angle bars, the life of the rail is about as great as when it is resawed, and more prompt reconditioning of rail by this process will greatly reduce the cost of the work.

Conclusions

The conclusions reached were:

1. That while there is no economy in rerolling rail at present high costs, that with the necessity for renewing rail of 100-lb. or greater section, the practice of rerolling rail will probably increase on account of the fact that the rerolled section will provide a relatively satisfactory section after rerolling.

As the quantity of rail to be rerolled increases the price of rerolling will be rapidly reduced.

2. That the resawing of rail for relayers is economical and is good practice; that it is desirable, when conditions warrant, to do this work with a portable rail saw.
3. That the reconditioning of joints with the oxy-acetylene process is a good practice and is the most economical method, all things considered, of reconditioning rail for renewal in the track.

Appendix E—Track Construction in Paved Streets and Highways

The committee recommends the following as a progress report:

1. Good results are being obtained from the use of both "T" and girder rail in paved city streets. Where girder rail is used, the following rail sections and accessories are recommended:
2. Plan of the 159-lb. girder rail section, to be designated as the "159-lb. G-9-in. Section."
3. Plan of the girder guard rail known as the 173-lb. or 174-lb. sections, which are identical, and to be designated as the "173-lb. GG-9-in. Section."
4. Plan of the joint bar to be used with the 159-lb. G-9-in. sections and 173-lb. GG-9-in. section, the same to be designated as "159-lb. G-9-in. Joint Bars."
5. Plan of the girder rail section known as the 127-lb. and 128-lb. sections, which are identical, and to be designated as "128-lb. G-7-in. Section."
6. For girder rail construction the use of the 159-lb. G-9-in. section, except under light rail traffic where the use of 128-lb. G-7-in. section may be found more economical.
7. The use of the 173-lb. GG-9-in. section, girder guard rail, which fishes with the 159-lb. G-9-in. section for guarding frogs, and on the inner rail of cruves where the life of the outer rail is limited by flange wear rather than by top wear.
8. Bolt holes 1⅛ in. diameter drilled in both ends of the 159-lb. G-9-in. section and the 173-lb. GG-9-in. section, with their center line 3¾ in. up from the base of the rail and spaced from the ends as follows: 2¾ in—7½ in.
9. Joint bars of the sections shown as the 159-lb. G-9-in. joint bars to be used with the 159-lb. G-9-in. section and 173-lb. GG-9-in. section 26 in. long with bolt holes punched 2¾ in.—7½ in.—5½ in.—2¾ in.
10. One and one-fourth inch high tensile steel bolts for use with the G-9-in. joint bars.
11. Ties of the best grade and class, preferably treated.
12. Tie plates of sufficient size to prevent cutting of the ties.

Data to Be Received as Information

1. The committee, after investigation, decided on the elimination of the 9-in. 141-lb. girder rail from further consid-

eration, by reason of the inferiority of this section for use.

2. Girder rail of 60-ft. length should receive favorable consideration as expansion and construction are not a factor in paved streets.

3. A girder guard rail section with the same joint fishing section as the 128-lb. G-7-in. section is not available but several sections can be obtained from the mills which will serve the purpose.

4. Joint bars as furnished by the manufacturers for the 128-lb. G-7-in. section may be used satisfactorily, but consideration is being given to a design of "Joint Bars," similar in section to the 159-lb. G-9-in. joint bars for this rail.

5. Tie rods are generally but not uniformly used in girder rail construction, in some instances special brace plates are used in lieu of the tie rods.

6. Ties are generally spaced 22½ in., the equivalent of 18 ties to a 33-ft. length.

7. A satisfactory paving for heavy vehicular traffic is stone block with concrete foundation, the depth of the latter depending on the nature of the sub-soil.

The committee recommends for future work, specifications for girder rail and subjects "C" and "D."

Discussion

[The report was presented by J. V. Neubert, vice-chairman, in the absence of Chairman W. P. Wiltsee. The committee changed its recommendation that Appendices C and E be approved for the Manual and instead submitted them as information. Its recommendations in Appendix B, were adopted without discussion.]

G. F. Hand (N. Y. N. H. & H.): In considering the re-rolling of the rail, I would like to ask whether they have taken into consideration the soundness of that rail after re-rolling.

President Ray: Some rail re-rolled by the Lackawanna some years ago, and which has been in service a good many years and is still in service, has shown some failures but nowhere near the number of failures which we have had in the new rail which we have bought in the meantime.

J. P. Lee (Industrial Works): Many engineers have thought that the action of the friction saw on the ends of an old rail hardened them and caused chipping and splitting after they were put in service. This theory has been exploded years ago. A properly operated friction saw will produce a rail end as uniform in hardness as at any other section of the rail. This has been tested by service and by file, hammer and sclerescope. There is just one essential to a proper and satisfactory sawing operation, plenty of water under high pressure playing on the saw and the cut in the rail.

A. F. Dorley (M. P.): Before conclusion No. 1, is passed the committee should give some further consideration to the effect on the quality and character of steel in re-rolling processes. On our road we re-rolled about 100 miles of rail about 12 years ago and the experience was extremely unfortunate. One particular stretch of about 50 miles of re-rolled rail was placed in an important main line and had to be taken out within 6 months. It reached the point where the rail had to be taken out and laid on a relatively unimportant line. As regards Conclusion No. 3, I would like to ask whether that conclusion refers to the re-conditioning of rail under traffic or the re-conditioning of rail after its removal and before its being placed back of the track.

Chairman Neubert: Question No. 1, is entirely a question of the condition of the service of the rail which you propose to re-roll. I don't know about the rail which was re-rolled 12 years ago, but it may be you took such rail as you had available for re-rolling.

W. H. Petersen (C. R. I. & P.): There is a use for each of the three types of fixing up the end of the rail. We are taking our curve worn rail and re-rolling it, and thus getting additional life out of it. We have got 160 miles of re-rolled rail in our track that has been there for 15 years and it has given us very good satisfaction. We have found that when rail ends become badly battered and you want to make use of that rail still further in secondary lines, it can be sawed off to good advantage. In the welding of the rail itself, there is a limit to where you are going to weld the rail. We welded some rail last fall that cost us five dollars a joint. The ends were battered down about an eighth of an inch. Now it would have been just as well to have sawed the rail, but we welded it because it was on a bridge where it would have been more expensive to have taken it out for re-sawing. Ordinarily the re-conditioning or the re-welding of the rail before the rail gets battered too much is the cheapest plan.

(It was moved and carried that the conclusions be adopted for publication in the Manual.)

(The committee was dismissed with the thanks of the Association.)

Report of the Committee on Rail

The Committee on Rail presented new specifications for rail in which the non-essential features heretofore causing dissention between rail manufacturers and railways have been eliminated. These specifications include a standard length of 39 ft., the committee expressing its belief that a rail length of 45 ft. was more economical and desirable. It collaborated with the Committee on Track and the Special Committee on Stresses in Track on the canting of rail, reported on by those committees. The committee also presented a recommended design for track bolts. In connection with the statistics on rail failures a method was suggested of compiling statistics, using a traffic density factor. G. W. Moore, the new chairman of the committee, has been a member for three years.

G. L. Moore
Chairman

THE COMMITTEE on Rail proposed the following revisions of the Manual: Revised Specifications for Open-Hearth Carbon Steel Rails (Appendix A), Recommended Design for Track Bolts including corresponding joint bar punching (Exhibit A.).

The committee presented standard rail specifications for consideration. The present standard specifications,

adopted in 1920, have not been used as a basis of contract, largely because of price penalties imposed by the rail makers. Practically all contracts in recent years have been based on the 1915 specifications. Such contracts when placed at the base price have necessarily waived such provisions as would have materially increased rejections.

The specifications now presented embody, in the judgment of the committee, only well-tried principles and eliminate in general non-essential features which have entailed dissension between rail manufacturers and railways. They have been reviewed in joint conference with the Rail Manufacturers committee in thoroughly amicable discussion. Contracts have been closed under similar provisions without penalties over the base price.

Rail Failures

The committee presented rail failure statistics for the period ending October 31st, 1923, as Appendix B. The average failures per 100 track miles per year of service for all the rail reported on are given below:

Year rolled	Years' Service 0	1	2	3	4	5
1908						398.1
1909					224.1	277.8
1910				124.0	152.7	198.5
1911			77.0	104.4	133.3	176.3
1912		28.9	32.1	49.3	78.9	107.1
1913	2.0	12.5	25.8	44.8	69.5	91.9
1914	1.2	8.2	19.8	32.9	50.9	74.0
1915	0.7	8.9	19.0	34.2	53.0	82.4
1916	1.6	11.8	29.2	47.7	70.6	105.4
1917	5.3	21.6	38.9	66.0	110.5	137.0
1918	1.6	8.9	27.6	54.0	92.8	125.4
1919	2.0	14.8	39.4	73.7	104.8	
1920	3.9	14.2	32.4	63.1		
1921	1.6	10.9	34.9			
1922	1.5	15.9				
1923	3.7					

The record of performance of the 1918 rolling shows, for the first time in five years, a drop in failures. It seems probable that the 1919 record for their five-year period will not be quite so good, but it will probably be well below the 1917 peak.

A suggested method for compiling statistics through the introduction of a traffic density factor was also presented for consideration in Appendix B. Its adoption will involve no additional burdens upon the reporting railways and will make the relative mill ratings considerably fairer.

Transverse Fissures

The committee last year reported the inauguration of a joint investigation of the underlying cause of transverse fissures, the parties then co-operating being the Bureau of Standards of the Department of Commerce, Rail Manufacturers Committee, the Special Committee on Stresses in Track, and the Rail Committee. The Bureau of Safety of the Interstate Commerce Commission participated in one of the early conferences, but later withdrew.

During the current year data were accumulated on both the mill and track history of nearly double the number of fissures available last year. Study of these data indicates substantial conformity with the tabulated data on the lesser number than available. There appears the same predisposition of certain furnace heats toward failures of this type. These data also emphasize the material lessening of transverse fissure failures during the recent years, under quantities and intensities of traffic greatly in excess of those producing relatively larger numbers of failures in earlier years' rollings. Tabulation of these data for presentation to the joint conference will be completed early in 1925.

Comparative Wear of Various Weights of Rail

The committee considered this topic only as to whether the rate of abrasion is materially affected by the size of the rail section. The experience of railroads handling heavy traffic and using the heavier sections of rail as standard shows greatly increased life of such rails on curves and also for general use, as is evidenced by the fact that it has not been necessary to increase the tonnage of rail purchased annually for renewals.

Data indicate variations in abrasion per million tons of traffic greater on any individual weight of section than obtain between the average wear of the lightest section and the average wear of the heaviest section. The variables of track maintenance, canting and chemistry of different rails, appear practically impossible of elimination through massed averages, and are probably preponderant over the influence of the size of the section as such in resisting abrasion.

Other Subjects

The joint committee sought assistance from the Special Committee on Stresses in Track in determining the relative stresses of varying traffic set up between rail laid vertically and rail canted. The report of the special committee is being presented to the Association direct and indicates, based on the tests, that

(a) Canting the rail inward reduces the lateral bending stresses in the rail for both tangent and curved track.

(b) Canting the rail inward causes a more central contact of wheel on rail.

(c) The most benefit is obtained from a cant of 1 in 20.

The Rail committee concurs in the findings of the Special Committee on Stresses in Track and recommends:

(1) Rail should be canted inward.

(2) Inclined tie plates should be used to produce the desired cant.

(3) Amount of cant should be 1 in 20.

The committee presented as Appendix C a preliminary report of the University of Illinois bearing upon the movement of contiguous rails through bolted joints, and the relation of bolt tension to mechanical strength of joints. It appears that lubrication by oil is not effectual in lessening resistance to slip, and that a sustained bolt tension of 1,000 lb. comes far from developing the attainable strength of the joint.

The committee presented as Exhibit A a track bolt design with the properties tabulated for sizes ranging by sixteenths from ¾ in. up to and including 1¼ in. rolled thread diameter. The design is confined to rolled thread bolts, optional properties being presented for the contour of the shoulder, type of thread, and periphery of nut. Corresponding joint bar punchings are presented for each type of shoulder.

The committee cannot reconcile the present diversity of angle bar punchings in track with any standard which will fit them all, but believes that the design presented for approval meets conditions existing on the majority of American track for renewals, and may be adopted generally for new construction.

The committee has included in the rail specifications a standard rail length of 39 ft. and many contracts for rail have been executed this year stipulating a 39-ft. length without entailing price penalty by the manufacturers.

The committee recognizes that the 45-ft. length is the most economical and most desirable, but present average car lengths do not permit of ready transportation and mill facilities are not yet afforded for their manufacture. The committee presents its confident belief that rail mills in remodeling may provide facilities for the production of 45-ft. lengths.

The committee devoted earnest study to the welding

of traction and signal bonds. Substantial applications of this nature have been made in track. It appears that the gas welding of bonds materially affects the structure of the rail in the vicinity of the point of application. Rail breakages from the use of gas welded bonds, however, appear confined to cases in which bonds have been welded to the web or base of the rail outside the joint structure.

The committee feels that the determination of maximum permissible wheel loads on steel rail is one of the most important subjects assigned to the Rail committee for many years. It is very difficult of intelligent attack, in that it is impracticable to accurately determine the effect of rolling loads on rails through the use of a reciprocating machine or a circular test track without very considerable expenditure. This question involves a general principle of mechanics on which apparently no data has ever been collected by research.

The committee presented in an Appendix A an analysis of the limits of rail wear on curves together with data accumulated from a questionnaire. It does not believe that further study would be fruitful, and requests that it be relieved of consideration of the subject.

The committee recommended that specifications submitted with the report in Appendix A, Specifications for Open-Hearth Carbon Steel Rails, be adopted by the Association and substituted for the corresponding specifications now printed in the Manual, and that the design of track bolts, submitted with the report as Exhibit A, Design for Track Bolts, be accepted as standard and printed in the Manual.

Committee: G. L. Moore (L. V.), chairman; Hunter McDonald (N. C. & St. L.), vice-chairman; E. E. Adams, (U. P.), W. J. Backes (N. Y. N. H. & H.), F. L. C. Bond (C. N. R.), C. B. Bronson (N. Y. C.), W. C. Cushing (Penna.), J. B. Emerson (Engr. Rail Com.), J. M. R. Fairbairn, (C. P. R.), C. F. W. Felt (A. T. & S. F.), L. C. Fritch (C. R. I. & P.), E. A. Hadley (M. P.), C. R. Harding (S. P.), J. D. Isaacs (S. P.), C. W. Johns (C. & O.), R. Montfort (L. & N.), A. W. Newton (C. B. & Q.), J. R. Onderdonk (B. & O.), W. H. Penfield (C. M. & St. P.), Earl Stimson (B. & O.), F. L. Thompson (I. C.), F. M. Waring (Penna.), Louis Yager (N. P.), J. B. Young (P. & R.).

Appendix A—Standard Specifications for Open-Hearth Carbon Steel Rails—1924

Inspection. 1. Inspection and tests shall be made at the work of the manufacturer before shipment, and the works management shall afford all reasonable facilities for determining the satisfactory quality of the rail accepted.

Chemical Composition. 2. The chemical composition of the steel, determined as prescribed hereafter, shall be within the following limits:

	WEIGHT IN LB. PER YARD			
CONSTITUENTS	70–84	85–100	101–120	121–140
Carbon	0.53–0.70	0.62–0.77	0.67–0.83	0.72–0.89
Manganese	0.60–0.90	0.60–0.90	0.50–0.90	0.50–0.90
Phosphorus, not to exceed	0.04	0.04	0.04	0.04
Silicon, minimum	0.15	0.15	0.15	0.15

Average Carbon. 3. (a) In any rolling, it is desired that the number of heats above the mean carbon percentage of the specified range shall be at least equal to the number of heats below the mean, and that the average carbon shall be as high as the mean.

(b) For information only, the manufacturer shall furnish the carbon and manganese analysis on drillings taken from both the "O" and "M" position of the head at the top end of the "A" rail of the last full ingot rolled on each tenth heat.

Analyses. 4. Separate analyses shall be made from drillings taken from test ingots representing the second and one of the last full ingots of the heat to determine the percentage of carbon and manganese. The percentage of phosphorus, sulphur, and silicon shall be determined on equally mixed drillings from the test ingots. The average analysis of the ladle test ingots shall conform to the chemical requirements. A portion of the drillings shall be furnished to the inspector upon request for check analysis.

Physical Requirements. 5. Ductility and resistance to impact will be determined by the standard A. R. E. A. drop testing machine, with test specimens from 4 ft. to 6 ft. long cut from the top of the "A" rails from the second, middle and last full ingots of each heat. The distance between supports shall be 3 ft. for sections under 106 lb. For sections 106 and over it shall be 4 ft.

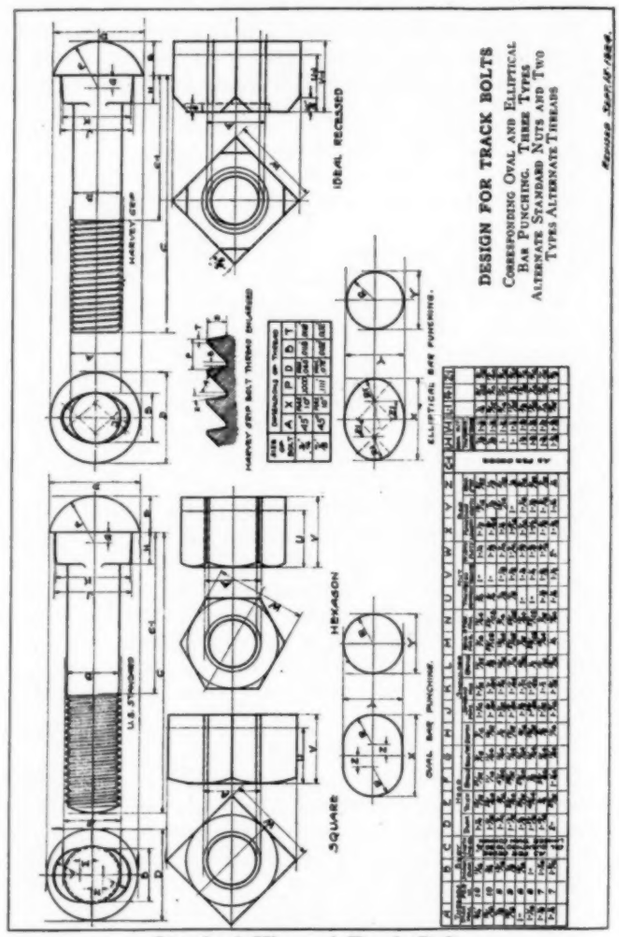
Temperature of the test pieces must not exceed 100 deg. Fahr.

Drop Test. 6. The test specimens shall be preferably placed base upwards on the supports and subjected to one blow from the top, falling free from the following heights:

For 81- 90 lb. rail inclusive.....18 ft.
" 91-100 lb. " " .....19 ft.
" 101-120 lb. " " .....20 ft.
" 121-140 lb. " " .....22 ft.

If all these specimens endure the above tests without fracture ,all the rails of the heat will be accepted, subject to final inspection for surface, section and finish.

If one of the three specimens fail, all the "A" rails of the heat will be rejected. Specimens shall then be cut from the bottom end of the same "A" rails or the top end of the "B" rails and tested. If any of these tests fail the "B" rails


DESIGN FOR TRACK BOLTS
Corresponding Oval and Elliptical Bar Punching. Three Types. Alternate Standard Nuts and Two Types Alternate Threads
IDEAL RECESSED
HEXAGON
SQUARE
OVAL BAR PUNCHING
ELLIPTICAL BAR PUNCHING.

Standard View of Track Bolt

of the heat will be rejected. Three additional specimens shall then be taken from the bottom end of the "B" rails or the top end of the "C" rails. If all these tests stand, the balance of the heat will be accepted. If any of these tests fail, the entire heat shall be rejected.

Elongation and Permanent Set. 7. (a) One of the three test specimens shall be given a sufficient number of blows to determine, for information only, the exhausted ductility, reported inch by inch over the entire six inches gaged. No ductility readings will be taken between blows. The other two specimens shall be nicked and broken. The fracture of each specimen shall be examined to determine the requirements of Section 8.

(b) For information only, the permanent set measured by middle ordinate in inches in a length of three feet shall be recorded after the first blow on all test specimens.

(c) For information only, one of the three test specimens shall be tested by Brinell indentation upon the head of the rail, and the diameter of the indentation shall be entered

upon the test record. The ball shall be 19 millimeters in diameter and the pressure 100,000 lbs.

Interior Condition. 8. If the fracture on any test specimen exhibits seams, laminations, cavities, interposed foreign matter, or a distinctly bright or fine grained structure, all top rails represented shall be classified as "X-Rayls."

Classification.

9. No. 1 Rails. No. 1 rails shall be free from injurious defects and flaws of all kinds.

X-Rayls. Rails as described in Sections 8 and 15-c.

No. 2 Rails. Rails which conform to the following requirements will be accepted as No. 2 rails.

(a) Rails which do not contain surface imperfections in such number or of such character as will in the judgment of the inspector render them unfit for recognized uses.

(b) Rails arriving at the straightening presses with sharp kinks or greater camber than that indicated by a middle ordinate of six inches in 39 feet.

Discard. 10. Sufficient discard shall be taken from the ingot to insure freedom from injurious segregation and pipe.

Lengths. 11. Standard length of rails shall be 39 ft. at a temperature of 60 deg. Fahr. Eleven per cent of the entire order will be accepted in shorter lengths varying by one foot from 38 ft. to 25 ft. A variation of 3/8-in. from the specified length will be allowed, except that on 15 per cent of the order a variation of 7/8-in. will be allowed.

Section. 12. Section of rails shall conform as accurately as possible to the templets furnished by the purchaser. A variation of 1/64-in. less or 1/32-in. greater than the specified height will be permitted. A variation of 1/16 in. in the length of either flange will be permitted, but the variation in total width of base must not exceed 1/16 in. No variation will be allowed in dimensions affecting the fit of the joint bars, except that the fishing templet approved by the purchaser may stand out not to exceed 1/16-in. laterally.

Weight. 13. A variation of one-half of one per cent from the calculated weight of section as applied to the entire order will be allowed.

Drilling. 14. Circular holes for joint bolts shall be drilled to conform to the drawings and dimensions furnished by the purchaser. A variation of 1/32-in. in the size and location of bolt holes will be allowed.

Finishing. 15. (a) All rails shall be smooth on the heads, straight in line and without twists, waves or kinks. When placed head up on a horizontal surface, rails that are slightly higher at the ends than the middle will be accepted, provided they contain a uniform sweep, the middle ordinate of which does not exceed 1¼ in. in 39 ft. They shall be sawed square at the ends, a variation of not more than 1/32 in. being allowed, and burrs shall be entirely removed.

(b) Rails presented for inspection which do not conform to the requirements of Section 14 or Section 15-a may be re-conditioned by the mill, provided they can be made to fully meet the requirements.

(c) When any finished rail shows conditions as described in Section 8 at either end or at any drilled hole, it shall be cut back to sound metal, and accepted as an "X-Rayl."

Branding. 16. Brands made so plain and sharp that they may be read as long as the rails are in service shall be rolled on or hot stamped into the side of the web of each rail in accordance with the following requirements and to indicate:

(a) Name of the manufacturer, the month and year of manufacture, and the weight and type of section of rail as rolled.

(b) The heat number and the ingot number as rolled shall be stamped in the web of each rail where it will not be covered by the joint bars.

(c) The top rails shall normally be lettered "A" and succeeding ones "B," "C," "D," "E," etc., consecutively, but in case top discard is greater than normal, the rail lettering shall conform to the amount of discard, the top rail becoming 'B" or other succeeding letter to suit the condition.

(d) All rails shall be branded "O-H" in addition to other marks.

Classification Markings. 17. (a) Rails accepted as "X-Rails" shall have the ends painted brown and shall be stamped with the letter X on both end faces.

(b) "A" rails shall have both ends painted yellow.

(c) Rails accepted as No. 2 rails shall have the ends painted white and shall be stamped with the figure 2 on both end faces.

(d) No. 1 rails less than 39 ft. long shall have both ends painted green.

(e) All rails of heats whose carbon content exceeds the mean carbon percentage of specific range shall have both ends painted blue.

Individual rails shall be painted only one color according to the order of precedence listed above.

Loading. 18. Rails shall be carefully handled in such manner as to avoid injury, and shall be loaded as follows:

(a) No. 1 low carbon rails shall be loaded in separate cars.

(b) No. 1 high carbon rails shall be loaded in separate cars.

(c) No. 2 rails shall be loaded in separate cars.

(d) "X-Rayls" shall be loaded in separate cars.

(e) No. 1 "A" rails shall be loaded in separate cars.

(f) No. 1 Short rails shall be loaded in separate cars.

No sub-division by classification markings other than listed above is necessary for separate loading.

Mill Practices. 19. The entire process of manufacture shall be in accordance with the best current state of the art. It is expected that thoroughly deoxidized dead setting steel will be furnished and that in every stage of manufacture strict adherence to the standards of best practice of the individual mill will be observed.

Shall anything occur in the process of manufacture which, in the judgment of the inspector, varies detrimentally from regular care and practice, the inspector will immediately notify the chief inspector and the general superintendent of the mill, confirming such report in writing. If after full investigation the inspector is not satisfied as to the good quality of the rails in question, and the rails, complying in other respects to this specification, be loaded for shipment, the inspector will immediately forward a copy of this report to the purchaser.

Acceptance and Payment. 20. (a) In order to be accepted, the rails offered must fulfill all the requirements of this specification.

(b) No. 2 rails to the extent of eight per cent of the whole order will be accepted.

(c) Rails accepted will be paid for according to actual weights.

Appendix C—Preliminary Report of Tests of Rail Joints

The end-load tests have been made on one of the rail joints shipped by Hunter McDonald, chief engineer, Nashville, Chattanooga & St. Louis. These tests were made by applying a compression load endwise of the rails, a definite tension having been placed in the bolts before each test. The joints were tested both dry and oiled. A number of repetitions of the load were applied.

The relation between a tension in a bolt and the torque required to turn the nut was determined for each bolt. This torque was used in applying the specified tension in the end-load tests. Repeated tests showed that there is a considerable variation from time to time in the torque required to produce a given tension in the same bolt.

The tension in the bolts was also measured by the use of an extensometer applied to the two ends of the bolt, the apparatus having been calibrated by determining the stretch of the bolt when placed in a testing machine under various loads. Calculation of the value of the tension in the bolts for the end-load tests from the measurement of their stretch has not been completed, but it is thought not necessary to do this at this time. The actual bolt tension applied may vary somewhat from the values noted, but the difference can not be great.

The end-load tests were made at bolt tensions of approximately 1,000, 2,000, 4,000, 6,000, 8,000, and 12,000 lb. For a given bolt tension, the load required to cause a slip in the joint and that required to continue the motion for a distance of about 0.02 in. were obtained and semi-automatic load-slip diagrams were taken. At the lower bolt tension there was no noticeable difference in the load producing slip and that required to continue the slip; at the higher bolt tension the load continuing the slip was slightly lower than that starting it. After the joint had slipped about 0.02 inch, the load was taken off to about 100 lb. and then the load was applied until the joint slipped another 0.02 in. This procedure was continued until the joint had slipped a total of about 0.3 in., 15 applica-

tions or so being thus made for each set-up. It was found that the load required to produce slip during the first 0.15 in. of slip or so was approximately constant. There was then an increasing load through, say, the next 0.10 in., after which the load remained approximately constant through the next 0.05 in., when the joint was found to be nearly closed and the load rose without further slip until the testing machine was stopped. For a given bolt tension the joint in a dry condition (without lubricant) was loaded twice in the manner just described, and then the contact surfaces were well lubricated with oil and two sets of tests were made in the same way. The oil used was obtained from the Locomotive Testing Laboratory and was that used for the test locomotive.

Observation made on the motion of each rail end with respect to the angle bar showed that the upper rail always slipped about 0.25 in. and stopped slipping, the bolt evidently then reaching the edge of the hole, before the lower rail started to slip. The average load required to produce slip during the first 0.15 in. of slip was then taken as the load required to slip the upper rail, and the load required to produce slip during the last 0.06 in. of closure was taken as the load required to slip the lower rail.

From the results it appears that the load required to slip a rail in the joint is approximately proportional to the tension of the bolts, but that the load required to slip one rail may be twice as much as that required to slip the rail at the other end of the same joint. It may be expected then that there will be a great variation in the force required to produce slip in different joints even when there is the same bolt tension.

The tests indicate that the effect of oiling the joint was negligible at the higher bolt tensions, although apparently the slip load was reduced somewhat at the lower bolt tensions. It should be noted, of course, that the joint tested was a new joint and did not have rust or other troublesome conditions.

Lateral bending tests were made at bolt tensions of 1,000 lb. and 12,000 lb. The rail was placed with the vertical axis of the section in a horizontal plane and the bending load was applied vertically. The supports were spaced 46 in. apart and the load was applied at two points 26 in. apart. Deflections of the head of each rail were measured and the stresses at the center of the joint were observed. A load deflection graph was also obtained from tests on one piece of the rail, from which it will be possible to compute the constant EI and the theoretical lateral deflection of a piece of full rail of the same length and loaded in the same manner as the rail joints tested. Computations on this have not yet been made.

The lateral bending tests showed that the deflection of the joint assembled with bolt tension of 1,000 lb. was approximately twice as great as the deflection when the bolts were drawn up to a tension of 12,000 lb. The maximum stress in the angle bar was also 50 per cent higher when the bolt tension was 1,000 lb. than when the tension was 12,000 lb.

The tests were made by L. J. Larson, associate in theoretical and applied mechanics, who conducted the work very carefully and with good judgment.

Discussion

J. R. W. Ambrose (Toronto Term.): Mr. Campbell was called away and he left a memorandum here to be read. "I suggest the desirability of designing rail sections so as to give one width of rail base and rail head to several weights of rail as, for example, a base width of 6 in. for 100, 110, 120 and 130 lb. rail and a width of 7 in. for 140, 150 and 160 lb. rail. This can be done so that all present requirements as to stability against overturning, moment of inertia, section modulus and percentages of metals in head, web and base of standard rail sections will be fully satisfied. One width of base and head would also simplify the tie plate matter when weight of rail is changed, saving trouble and expense."

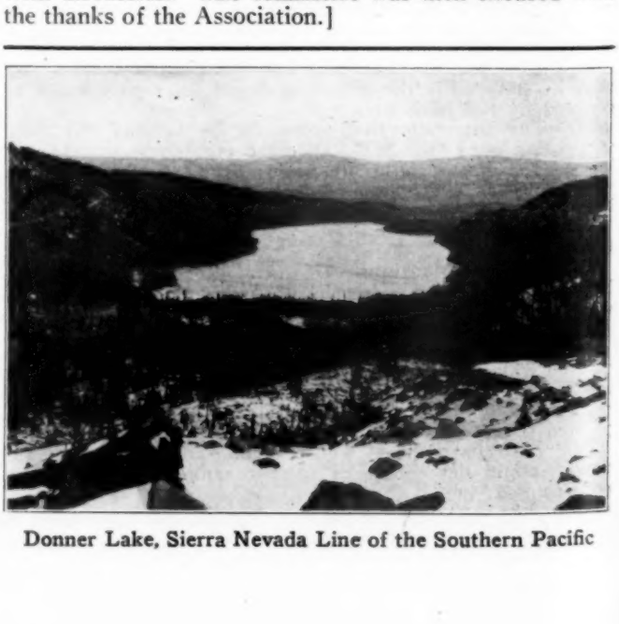
G. H. Tinker (N. Y. C. & St. L.): Under the heading "Classifications, paragraph 9-B", I would like to ask why the committee adopted six in. when the manufacturers do not ask for it?

J. B. Emerson (Engr. Rail Com.): The whole effort of the rail committee has been concentrated to as great an extent as possible to avoiding the effects of unnecessary straightening as a class. The new specifications bear a provision that a uniform sweep which does not exceed a certain amount is unnecessary to eliminate.

Mr. Tinker: There is one other point that is mentioned, that of allowing a uniform sweep and not straightening the rail. That is a very important specification. Any man who has inspected rails knows how easy it is to be fooled on the amount of camber. I defy one man out of a hundred to tell what the camber of the rail is without stretching a wire. An inch and a quarter will look like half a foot. The old specification was far better to say nothing about any allowances of uniform sweeps.

Mr. Emerson: The quantity of the permissible sweep, it has appeared to the committee, is something which should be nominated in the specification and not left to the responsibility of an individual inspector. While the inch and one-quarter, inch and one-half or two inches, or any limit that might be reasonably set, might be difficult of continued measure by wire-stretching which, as Mr. Tinker said, is the only accurate method of doing it. It is a whole lot better for the average commercial inspector who has to take up the material to have a set amount on which he can base his judgment, his check against his eye, by frequent wire measurement, than it is for the man to accept rails which, in his own judgment, do not contain sufficient sweep, have them get out to the railroad company whom he is serving, and then have his inspection company challenged by reason of a certain amount of sweep in rail in which the specification provides for none.

[*A motion to accept the rail specifications for publication in the Manual was carried.* The other sub-committee reports were accepted as recommended in the report and with discussion. The committee was then excused with the thanks of the Association.]



Donner Lake, Sierra Nevada Line of the Southern Pacific

Report on Wooden Bridges and Trestles

The Committee on Wooden Bridges and Trestles presented a progress report on the useful strength of new, old and treated timber where used in railway trestles, including a critical examination of the present theories of stresses when applied to timber under railway load conditions. The committee also presented a report on the classification of uses of timber and lumber under A. R. E. A. specifications in which it called attention to the standardization program developed by the timber industry, resulting in the American Lumber Standards, Recommendation No. 16, of the U. S. Department of Commerce. It further reported on the relative merits of open and ballast deck timber trestles. A. O. Ridgway, who has been chairman of the committee for three years, has been a member since 1915.

A. O. Ridgway
Chairman

THE COMMITTEE presented a report covering (1) Revision of the Manual in Appendix A (no changes were recommended). (2) The useful strength of new, old and treated timber when used in railway trestles, including a critical examination of the present theories of stresses when applied to timber under railway load condition in Appendix B; (3) The classification of the uses of timber and lumber under American Railway Engineering Association Specifications in Appendix C; and the relative merits of open and ballast deck trestles in Appendix D.

The action recommended was that the final report on Appendix B be received as information; that American Lumber Standards — Exhibits A and B, Appendix C—be adopted by the Association and substituted for the specifications for timber and lumber now appearing in the Manual; that the classification of uses of timber and lumber for railway purposes, Exhibit C in Appendix C, be adopted by the Association and printed in the Manual; and that the four enumerated conclusions on Relative Merits of Open and Ballast Deck Timber Trestles, Appendix D, be adopted for printing in the Manual, together with the two diagrams for the graphical determination of "Annual Investment Cost, Wooden Bridges and Trestles."

Committee—Arthur Ridgway (D. & R. G.), chairman; J. B. Maddock (C. of Ga.), vice-chairman; H. Austill (M. & O.), O. C. Badger (A. T. & S. F.), Charles Chandler (I. C.), C. R. Chevalier (P. T.), W. J. Gooding (S. A. L.), E. M. Grime (N. P.), W. E. Hawley (D. M. & N.), H. T. Hazen (C. N. R.), C. S. Heritage (K. C. S.), C. J. Hogue (West Coast Lumbermen's Assn.), D. F. Holtman (Con. Engr.), W. H. Hoyt (D. M. & N.), T. F. Laist (Nat. Lumber Mfr. Assn.), J. A. Newlin (Forest Products Lab.), C. E. Paul (Armour Inst. of Tech.), G. W. Rear (S. P.), D. W. Smith (H. V.), G. C. Tuthill (M. C.), J. T. Vitt (Wabash), S. L. Wonson (M. P.), S. R. Young (A. & W. P.).

Appendix B—The Useful Strength of New, Old and Treated Timber When Used in Railway Trestles

This committee has in previous reports presented to the Association tables for the permissible working values of timber of various kinds under various stresses. These values are those recommended by the Forest Products Laboratory after many tests. No tables of values to be used with treated timber have been prepared, and cannot be until more extensive strength tests of timber with various methods of treatment have been made. Reports of tests which have been given previously are based upon processes which have destructively cooked the timber or else were not extensive enough to form the basis of conclusions which could be applied to present day processes.

The design of railway timber bridges and trestles requires the use of the many different properties of timber in many combinations. This design cannot be made by rigid analysis of mathematical process because of the numerous variations of conditions. Timber is not homogeneous in its various dimensions, and its resistance to stresses varies over a very wide range.

The assumptions used in the development of the beam formula do not hold after the elastic limit is passed. This is particularly true with wood where there is a large difference in the tensile and compressive strength. The assumption that a plane section perpendicular to neutral axis remains a plane section perpendicular to neutral axis is not true within the elastic limit for any material, and is especially erroneous for wood where there is a large difference between the modulus of elasticity and the shearing rigidity. These assumptions do not cause any material error in computing the stress in the extreme fiber, but do result in large errors in computing the shear in beams when the load approaches the reaction. The error is especially large in checked beams in which, in extreme cases, the actual stress developed is not only about one-third that indicated by the formula. Until more information is available, no change can be made in the present recommendation for computing shear stresses.

The modulus of elasticity given in tables of working stresses is usually an average value intended for use in computing the average deflection of beams. In using such figures to compute the deflection of beams it must be remembered that this property varies widely in clear wood although it is affected but little by defects. Timbers are slightly plastic, and under long durations of stress receive a permanent set. A factor of 2 is usually used with the modulus of elasticity to compensate for this sag.

The present practice is to consider the stringer loads as so many concentrated point loadings, neglecting the distributing effect of the rail and ties and the total depth of the complex structure of rail, tie, and stringer. The rail is spiked to the ties and the ties are spiked or

bolted to the stringers, forming more or less a truss system. The rail distributes the point load of the wheels over some appreciable length of the stringers through the means of broad ties usually assumed three in number. The load on the stringer approaches in character uniform rather than concentrated loading. The rail and its angle bar joints have a large amount of bending moment resistance for such lengths as three tie spacings and a high resistance to end shear.

The quality of continuity exists between adjoining spans in railway trestles because usually some stringers are of two spans length. The amount of this action is uncertain because of the elasticity of the supporting bents and the number of members transmitting stresses from one panel to another. Frame and pile bents introduce further problems such as the relative distribution of loading among the columns and the proper proportioning of bracing and fastenings.

The Committee concludes that the design of wooden trestles must be put in the same class as many other subjects reported on by committees of the Association.

1. There is no rigorous and exact science in proportioning the various parts of a timber trestle, but the best previous knowledge tempered with good judgment must be relied upon to produce satisfactory designs.
2. Formula and stress values must be used with discretion aided by knowledge of the results of timber research.
3. The appraisal of the useful strength of wood must be matter of good judgment. No absolute value for the strength properties of wood can be given and invariably used.
4. The design of timber structures of treated material should be based upon reduced values of working stresses determined by judgment from knowledge of the specific timber and the process to be used in its treatment.
5. The classification of old structures of treated timber must be done as a matter of examination for development of defects and judgment of the effective strength left in the timber. No arbitrary stress values can be set up advisedly.

Appendix C—The Classification of Uses of Timber and Lumber Under American Railway Engineering Association Specifications

This subject directs the practical application of grading rules for lumber and timber to the railroad uses of these materials. Specifically it refers to specifications of the American Railway Engineering Association. Since the publication of these rules an organized standardization program has been developed by the lumber industry, participated in by producers, distributors, and consumers. Resulting from such cooperation, American Lumber Standards have been adopted and are specifically described in Simplified Practice Recommendation No. 16 of the U. S. Department of Commerce. These rules took effect July 1, 1924. The Central Committee on Lumber Standards has also adopted basic provisions for structural grading.

Southern Pine and Douglas Fir

	Dry Inside Location	Ordinary Outside Location	Damp or Wet Location
Joists and Rafters (In Dry Locations):			
Select Dense			1,750
Select			1,600
Common			1,200
Beams and Stringers:			
Select Dense	1,750	1,500	1,200
Select	1,600	1,400	1,100
Common	1,200	1,050	800
Posts and Square Timbers 66" x 6" and Larger:			
Select Dense	1,300	1,200	1,000
Select	1,200	1,100	900
Common	1,000	900	750

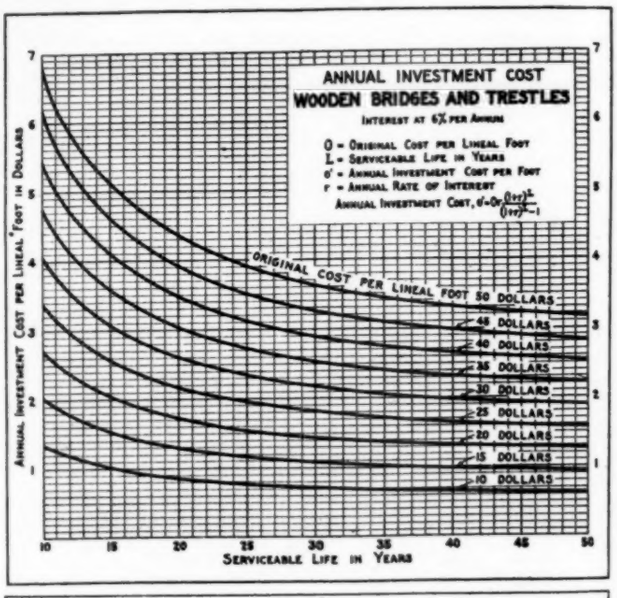
The committee has therefore interpreted its subject as the Classification of Uses of Timber and Lumber in Railway Construction under American Lumber Standards.

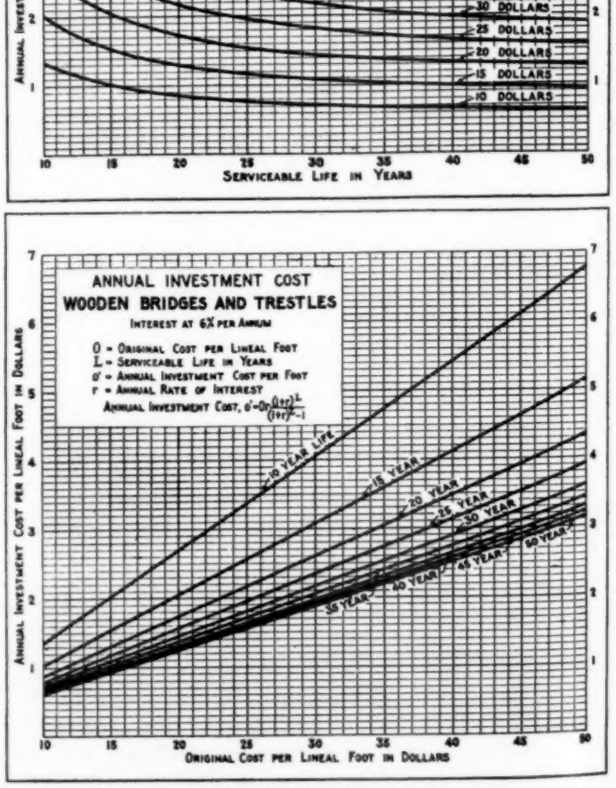
To facilitate the application of these standards, the necessary parts of the yard lumber standards and an edited arrangement of rules for structural timber based upon the basic rules adopted have been included in Exhibits A and B.* The application of these standards to railroad use is shown in Exhibit C. [This long listing was omitted for lack of space.]

The details of the allowable defects of structural timber grades were worked out on the basis of the tabulated permissible stresses in bending in pounds per square inch in the locations indicated on recommendations made by the Forest Products Laboratory.

Appendix D—Relative Merits of Open and Ballast Deck Timber Trestles

It seems natural to think of the open deck as constructed of untreated timber and the ballast deck of treated timber. Renewal of a ballast deck trestle under traffic entails such expense that it is desirable to lengthen the interval between renewals as much as possible. In the case of open deck construction, renewal under traffic


ANNUAL INVESTMENT COST
WOODEN BRIDGES AND TRESTLES
INTEREST AT 6% PER ANNUM
O = ORIGINAL COST PER LINEAL FOOT
L = SERVICEABLE LIFE IN YEARS
o' = ANNUAL INVESTMENT COST PER FOOT
r = ANNUAL RATE OF INTEREST
ANNUAL INVESTMENT COST, o'=Or (1+r)^L / (1+r)^L-1
ORIGINAL COST PER LINEAL FOOT 50 DOLLARS
45 DOLLARS
40 DOLLARS
35 DOLLARS
30 DOLLARS
25 DOLLARS
20 DOLLARS
15 DOLLARS
10 DOLLARS
ANNUAL INVESTMENT COST PER LINEAL FOOT IN DOLLARS
SERVICEABLE LIFE IN YEARS


ANNUAL INVESTMENT COST
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o' = ANNUAL INVESTMENT COST PER FOOT
r = ANNUAL RATE OF INTEREST
ANNUAL INVESTMENT COST, o'=Or (1+r)^L / (1+r)^L-1
10 YEAR LIFE
15 YEAR
20 YEAR
25 YEAR
30 YEAR
35 YEAR
40 YEAR
45 YEAR
50 YEAR
60 YEAR
ANNUAL INVESTMENT COST PER LINEAL FOOT IN DOLLARS
ORIGINAL COST PER LINEAL FOOT IN DOLLARS

Charts for the Analysis of the Economics of Structures Affording Various Periods of Service Life

*The simplified practice recommendation was presented in abstract in the *Railway Age* for Aug. 2, 1924, page 205.

being comparatively easy, there is not quite the same inducement for the use of treated material. Viewed in this light, the advantage, if any, accruing to the ballast deck structure would be due primarily to its longer life, and the same advantage would be found in the use of treated material as against untreated in either type.

Some of the intangible advantages of the ballast deck trestle may be summarized as follows:

Fire protection, reflected in reduction in insurance premiums and continuity of service.
Appearance, reflected in passenger patronage.
Riding qualities, reflected in passenger patronage and maintenance of equipment.
Elimination of certain track problems, at times difficult if not impossible to overcome with the open deck.
Longer service life, due to greater load carrying capacity resulting from less disproportion of live and dead loads.

Relative Economy—The relative ultimate economy of the two types of timber trestles will depend upon first cost, length of serviceable life, and cost of maintenance.

The first cost of the ballast deck trestle is greater than the open deck. A comparative statement of the investment cost and maintenance cost of the two types of trestles would be evidence of their relative ultimate economy. Any estimated cost of either type would reflect local or regional conditions as costs vary widely due to geographical location.

The years of serviceable life of timber trestles vary in different territories and also depend on kind of timber used. The average life of an open deck trestle of untreated timber we believe to be from eight to twelve years in the central and eastern regions, and longer in the western region. The life of either a treated timber open or ballast deck trestle should anywhere be at least 25 years, and probably more.

Maintenance costs will vary with locality, volume and character of traffic, and physical conditions. Annual cost of maintenance of the open deck type is usually known for any road, but the maintenance cost of the ballast deck is not so well established. The form of comparison must therefore permit of variously assigned values, and may be stated mathematically.

Conclusions

Through its investigation and analysis of the matter, the Committee concludes as follows:

1. The open deck trestle has the advantage of the ballast deck in lower original cost, greater adaptability in temporary or emergency installations, and lower costs in effecting renewals under traffic.
2. The principal advantages of the ballast deck trestle when compared with the open deck type are:
   Better protection against loss and damage and interruption in train service due to fire.
   Superior track riding qualities.
   More satisfactory and safer appearance.
   Greater serviceability and better performance when subjected to overload.
   Vastly less expensive to maintain.
3. Because of the impossibility of segregating from operating expense accounts or allocating in operating revenue definite amounts resulting from the use of either type of structure, the true relative economy is not susceptible of mathematical demonstration.
4. As a safeguard against serious error in adopting either type in any individual case, the following rule can be relied upon for conservatism:

   "If the difference between the annual investment cost of the two types equals or only slightly exceeds the annual cost of maintenance of the open deck type, the ballast deck type will be the more economical."

Discussion

[In presenting the report Chairman Ridgway first called upon H. Austill, chairman of the sub-committee on the Manual revisions, who expressed the hope that the Board of Directors would give serious consideration to the suggestion that the work of each committee in the future be published in pamphlet form so that the proceedings could be kept in a loose leaf binder form for convenience in keeping the record up to date and making revisions. The report on the classification of lumber, Appendix C, was then presented by W. E. Hawley, chairman of the sub-committee, who *moved that Exhibits A, B and C be adopted for inclusion in the Manual.*]

Dr. Hermann von Schrenk (N. Y. C.): *I would like to offer a substitute motion that Exhibit B and Exhibit C be adopted as information only.*

All that the American Lumber Standards have done is to develop a basis for writing grades. The American Lumber Standards have not written a single grade either for structural grading or for yard lumber. We are not writing rules but the basis for rules. As a further explanation of my reason for requesting that the committee bring this matter as information only, actual rules for the grading of structural timbers have not been written by any of the manufacturers' organizations except on a tentative basis. Further, neither the American Society for Testing Materials nor the American Railway Engineering Society officially approved the basis of grading yet. The committee has given us structural grade examples, which are not grading rules but are examples of how to grade. They are not rules that we can hand to the purchasing department and ask them to purchase any particular grade of lumber. What I would like to see the committee do is use this basis and next year give us actual rules. I have the same objections about Exhibit C. This is the most valuable classification which the committee has yet submitted to us, but on the other hand, you can't give this to a purchasing agent, nor can the engineer use it today in any specific manner. Until the committee can give us actual grades to substitute for those which we have in the Manual, we should not take those out of the Manual.

J. R. W. Ambrose (Toronto Term.): I would like to support the motion (last) presented. This is a committee on wooden bridges and trestles. There are not very many units in a trestle or a wooden bridge. We have in the Manual today a perfectly good specification for most of those units.

D. F. Holtman (Cons. Engr.): The rules which appear in the Manual at the present time are obsolete.

Dr. von Schrenk: Mr. Holtman says the rules are obsolete. A few minutes ago I had a telegram from the Secretary of the Southern Pine Manufacturers' Association, which manufacturers most of the Southern pine structural bridge and trestle timbers, advising that it is still manufacturing and still selling structural yellow pine under the rules of the A. R. E. A. I personally just approved three large contracts with the West Coast Lumber Manufacturers' Association under the present rules of the A. R. E. A., which orders were taken by the mills and are being furnished. In other words, I hardly think under those circumstances he is warranted in saving our rules are obsolete.

[*The amendment that the Exhibits B and C on the classification of timber be adopted as information only, was carried, whereupon the motion to adopt all three appendices was withdrawn and a motion made and carried, upon the request of Chairman Ridgway, to accept Exhibit A also as information.*

Appendix D, on the relative merits of open and ballast deck timber trestles was then presented and a *motion made and carried that the conclusions and diagrams be adopted for inclusion in the Manual.* The committee was then excused with the thanks of the Association.]

The Signal Section in Convention at the Drake Yesterday Forenoon

Signal Section Convenes At Drake

First day's session includes three papers relating to train control and the reports of eight committees

GENUINE enthusiasm was evidenced throughout the opening session of the annual convention of the Signal section of the American Railway Association at the Drake Hotel yesterday morning. The attendance was large. An unusual deviation from the regular reports of the committees was the inclusion of two papers on the subject of train control, this change being characteristic of the progressive policy which now characterizes the Signal section. G. H. Wood, supervisor of air brakes of the Atchison, Topeka & Santa Fe, presented a paper entitled, The Relation of the Air Brake to Train Control. Train Operation by Signal Indication—Especially by Cab Signals was the subject of a paper presented by A. H. Rudd, chief signal engineer of the Pennsylvania. The reports of the eight committees were given thorough consideration but the discussion was handled so expediently as to give ample time for the presentation of the papers. The growing attendance at these conventions is evidenced by the fact that 449 members registered during the day.

Chairman's Address

Following the disposal of the opening business W. M. Vandersluis (I. C.), chairman of the Signal section, delivered an address in which he presented his views on several important problems before the signal field. An abstract of Mr. Vandersluis' address follows:

Thirty years ago yesterday, six men met in Chicago and formed what they called the Railway Signaling Club. The need of such an organization was evident and it grew rapidly. On March 11, 1919, when the Railway Signal Association, the successor to the Railway Signaling Club, was made a part of the American Railway Association, there were 1,227 members. Today there are 1,972 members on the rolls.

The gradual extension of signaling and interlocking work and the better methods of construction, maintenance and operation for which you are responsible, have been contributing causes to the handling of this business and to the greater efficiency obtained.

Compliance with the train control orders of the Interstate Commerce Commission has diverted moneys from the signaling and interlocking programs, but in spite of this there were installed last year 2,469 interlocking levers and 3,123 track-miles of automatic signaling, the largest numbers for any year since 1919.

Growing Interest in Committee Work and Broadening Scope of Programs

The men of this organization seem to me most modest. There are many now not working on committees who are thoroughly qualified and there are a few on committees who do not do their share of the work. Active members who can spare a little time should advise the secretary, stating their preference of committees. The good you will get out of personal contact with other men interested in your particular specialty, is out of all proportion to the time and energy expended.

With the growth of the Signal section and its development, the work of the committees has necessarily increased. For years the efforts of your committees have been largely confined to detailed work on specifications for materials, apparatus and construction, on plans and on contract forms, until today you have a manual of recommended practices that is a credit to the organization.

There have been for several years, however, intimations from various sources that too much time has been spent on detail and to offset these criticisms an effort was made at the September meeting last year to increase interest by devoting a day to papers on train control and other vital questions. The subject of train control taken up last September was certainly a live one, and it is hoped that some good was accomplished.

At this meeting that policy is being continued and the program for this session provides for three papers on train control, covering a phase not touched at the last meeting, and several papers on another vital subject—the operation of trains by signal indication. It should be borne in mind, however, that the detailed work is and should be ever with us. The advance notices of the two yearly meetings tell this year's story.

In this day, with every interest and trade represented by its own organization, it is natural that there should be some overlapping of work. To avoid duplication, cooperative work with other organizations has been developed, your association having representatives working with nine other associations.

Suggestions for Growth

I would like to suggest a few things which to me seem important, some of which cannot be stressed too much:

Work diligently on a reliable, economical and uniform system of train control, co-operating to the fullest extent with all regulating bodies having the matter in hand.

Develop an adequate system of records, especially covering the first costs, maintenance and operation costs and efficiency of operation of train control systems.

Develop a scheme to secure and train young technical engineers for the signal department organizations.

Extend as rapidly as consistent educational work, which should include the distribution of literature on pertinent signal subjects.

Develop further the economies incident to railway signaling.

Develop authentic information on braking rates of freight and passenger trains of different classes. This information is fundamental in properly laying out signals and train control systems, but the facts at hand are meager and such as do exist are not easily available. Co-operate with the Air Brake Association on this work.

Extend Usefulness by Co-operation

The Signal section in its 30 years' work has overcome many difficulties, broadened its scope and achieved great things, and the work must go on. Every phase of railroad work is rapidly developing and changing and we must be awake and ready to meet every advance.

Mr. Ray, president of the American Railway Engineering Association, mentioned in his opening address on Tuesday morning, the need of closer co-operation between the different divisions and sections of the American Railway Association and especially with the Signal section. For the mutual benefit of both organizations, he suggested having more men of each organization in the committees of the other and the advisability of working out the dates for the March meetings so that closer co-operation may be obtained.

W. M. Vandersluis
Chairman

Report of Committee of Direction

The Committee of Direction called attention to some twenty or more matters upon which it has acted during the period from March 14, 1924, to March 12, 1925. Among the most important of these matters was the following resolution which has been approved by letter ballot:

"Resolved, that an electrically or mechanically operated signal, used for the protection of highway traffic at railroad crossings shall present toward the highway, when indicating the approach of a train, the appearance of a horizontally swinging red light and or disc."

The Committee authorized Chairman Vandersluis to advise the Telegraph and Telephone section that Committee IX-Overhead and Underground Lines has approved its specifications for underground crossings.

The sub-committee submitted a proposed revision of the basis for determining the votes allowed each representative member. It is proposed that additional votes be allowed on the basis of each 500 miles of track equipped with track circuits rather than on each 500 miles of track. After considerable discussion *a motion to accept the revision was lost.*

H. S. Balliet, secretary of the section, in his annual report stated that there had been a net growth of 172 members last year, the membership now totaling 2,001. The work of the association is primarily that of the committees there being a total of 105 committee meetings last year with a total attendance of 434 members. Eight publications were issued by the association in the period covered by the report, containing a total of 2,218 pages of printed matter.

Summary of Train Control Papers

The paper by G. H. Wood, The Relation of the Air Brake to Train Control covered many important points to be considered by those designing and installing train control. A few of the most important items included follow:

Brake manipulation must vary with different train make-ups, lengths, weights, speeds, etc. It follows, therefore, that in the development of such automatic devices, the methods used by the engineman must be duplicated, at least to a degree which will provide satisfactory handling of the train without discomfort to passengers or damage to equipment or lading. If, however, the results in train handling under the automatic manipulation may be disregarded, this feature is simplified and it is only necessary to consider the maximum stopping distance as indicated by operating requirements. This is somewhat of a perplexing problem as it varies for different localities and train conditions.

I have been asked many times in what distance a train may be stopped from various speeds. The question cannot be answered without information as to all other factors involved. The ability to control trains with automatic devices is predicated upon the control provided by the present air brake systems, the latter is therefore the foundation upon which each element of the automatic device must depend and its scope is limited only by the flexibility, efficiency and effectiveness of such braking systems.

The generally accepted standard for braking power on freight cars is 60 per cent of the weight of such cars, for service braking with 70-lb. brake pipe pressure, but since some cars are nearly five times as heavily loaded as when empty, the braking power is nominally only about 12 per cent and it is this condition that must be considered if interchange of equipment is common to operation. Experience will, of course, dictate the necessity for modifications in existing systems and it is possible that the future will witness a compromise between the brake systems and automatic systems which will permit of stopping both freight and passenger trains without criticism if the present systems fall short of this requirement.

A. H. Rudd, chief signal engineer of the Pennsylvania, in his paper Train Operation by Signal Indication—Especially by Cab Signals, explained his conclusions stating that in view of the development of the cab signal in the past 18 months on the Lewistown division that they are fully justified in stating that it is apparently as reliable as the wayside signal. Continuing Mr. Rudd said, "We are continuing the development of the three-speed continuous train control on the Lewistown branch, and we are proceeding with the installation of an automatic block system on the Baltimore-Harrisburg line, using signals without moving parts spaced for the future installation of continuously controlled cab signals and for

trains running with closed throttle at maximum authorized speed controlled by alternating current track circuits to reduce foreign current interference to a minimum, and including in the installation flashing lights indicating the approach of trains at many grade crossings.

On this we are superimposing cab signals giving three indications and arranging for a straight stop with the forestalling feature on the locomotives, the latter in accordance with the requirements of the Interstate Commerce Commission revised in July, 1924.

Cab signal will be the same as that in use on the Lewistown branch, and will operate so as to show "A"—Authorized—when the train is running in a clear block under clear signals; forestalling being required to avoid a brake application on each change to a less favorable indication, so that, if one train is following another, and the engineman does not forestall, a stop will result.

An analysis of cab signal performance, separated from train control performance, on the Lewistown Branch, during the 18 months from July 11, 1923, when the apparatus was placed in service, to January 10, 1925, inclusive (5,337 trips) shows approximately 384 irregularities. I say approximately as we may have missed one or two. For the first nine months, there were 233, and the second nine months 151, showing that we have progressively developed and improved the apparatus and eliminated failures.

Committee Reports

The Special Committee on Highway Crossing Protection submitted revised requisites for highway crossing signals. These 17 requisites covering both flashing light and wig-wag types of signals were recommended by the committee for submission to letter ballot superseding matter now in the Manual.

CommitteeII—Mechanical Interlocking was presented by W. N. Spangler (Penna.), chairman. Specifications for electro-mechanical interlocking machines, vertical locking were discussed and accepted for submission to letter ballot for inclusion in the Manual.

Committee V—Instructions submitted a report presented by J. S. Gensheimer (Penna), chairman. Instructions for the maintenance and operation of nickel-iron storage batteries and caustic soda primary batteries were discussed. Instructions for testing electric locking and definitions for technical terms also formed a part of the report. These instructions were accepted for submission to letter ballot.

Train control was the subject of the major portion of the report of Committee X—Signaling Practice which was presented by F. B. Wiegand (N. Y. C.), chairman. The report of the committee favored the elminations of wayside signals in train control territory. After considerable discussion on both sides of the question the report was accepted as information.

Among the noteworthy advances in signaling practice during the past year the committee reported: (a) The development and successful installation of the alternately flashing light highway crossing signals for announcing the approach of trains; (b) The use of cab signals providing continuous indication as a possible substitute for wayside signals; (c) The development of the position-color-light signal for governing the use of a track.

Committee VI—Designs, presented revisions for 10 drawings and also drawings for 6 new standards. Among the new standards the most important are Brackets for Numerals and Letters; Electric Lamp Cases; Semaphore for Two-Way Single Lamp Signal; and Gages for Sheet Metal and Wire.

Committee VIII—A. C. Block Signaling presented a report recording historical data pertaining to the use and the various methods of charging storage batteries for the operation of railway signal apparatus. This report was accepted as information.

Committee XI—Chemicals, of which I. S. Raymer (P. & L. E.) is chairman, presented specifications for hard fibre which were accepted for submission to letter ballot.

Committee IX—Overhead and Underground Lines submitted a report on specifications for wood poles and steel tubular poles, conductors, rubber insulation, magnet wire and cables. Five co-operative reports issued jointly formed a part of the work which was submitted by the committee.

American Railway Engineering Association Registration

A TOTAL of 30 members and 16 guests registered during the concluding sessions of the A. R. E. A. convention yesterday, bringing the total registration to 780 members and 208 guests, or a combined total of 988. This figure compares with a total registration to 780 members and 208 guests, or a combined total of 987 for last year. Thus the attendance this year virtually equals the record established last year.

Armistead, F. W., asst. engr., I. C., Chicago.
Backes, W. J., asst. gen. mgr., N. Y., N. H. & H., New Haven, Conn.
Blanchard, M. C., ch. engr., val. dept., A., T. & S. F., Western Lines, Amarillo, Texas.
Bouillon, A. M., designer, Chicago Terminal Improvements, I. C., Chicago.
Gamble, J. S., supervisor, Wabash, Montpelier, O.
Clark, H. G., asst. to pres., C., R. I. & P., Chicago.
Coburn, Maurice, asst. engr., Penna., St. Louis, Mo.
Green, F. W., V. P., St. L. S. W., St. Louis, Mo.
Greene, T. H., div. engr., C. & O., Clifton Forge, Va.
Hande, J. H., acct. engr., B. & O., Baltimore, Md.
Hynes, M. V., gen. supt., C., I. & W., Indianapolis, Ind.
Jacobs, J. C., asst. engr., I. C., Chicago.
Johnson, J. M., cons. engr., I. C., Louisville, Ky.
Johnston, C. E., V. P. and gen. mgr., K. C. So., Kansas City, Mo.
Kline, R. C., div. engr., A., T. & S. F., Winslow, Ariz.
Lee, E. H. (P. P.), V. P., C. & W. I., Chicago.
Lewis, O. A., supervisor, Wabash, Stanberry, Mo.
MacFarland, H. B., 828 E. Ferry St., Buffalo, N. Y.
MacMannis, T. E., inspector, B. & O., Baltimore, Md.
Murphy, H. C., dist. engr. M. of W., C., B. & Q., Lincoln, Neb.
Peterson, J. W., asst. engr., Minneapolis, Minn.
Raymond, Wm. G., Dean, College of Applied Science, University of Iowa, Iowa City, Iowa.
Russell, W. E., roadmaster, I. C., Champaign, Ill.
Shurtleff, A. K. (asst. secy.), 431 South Dearborn St., Chicago.
Smith, F. A., cons. engr., 2410 Smalley Ct., Chicago.
Staley, G. L., asst. bridge engr., Mo.-Kan.-Tex., St. Louis, Mo.
Thompson, F. W., div. engr., C., R. I. & P., Des Moines, Iowa.
Tuthill, G. C., bridge engr., M. C., Detroit, Mich.
Vawter, Jamison, asst. prof. civil engr., Univ. Ill., Urbana, Ill.
Worley, John, prof. trans., Univ. Mich., Ann Arbor, Mich.

Guests

Andrews, G. N., Counsel, I. C., Chicago.
Bell, C. M., designer, I. C., Chicago.
Bischoff, J. M., off. engr., T. R. R. A. of St. L., St. Louis, Mo.
Brozo, J. W., div. engr., A. T. & S. F., San Marceal, N. Mex.
Brueggemrey, H. C., asst. engr., N. Y. C. & St. L., Cleveland, O.
Chisholm, D. C., C. P., Fort William, Ont.
Collinsworth, J. R., asst. engr., I. C., Chicago.
Davidson, S. G., Grand Rapids, Mich.
Gehrke, E., Chicago.
Howard, H. S., asst. engr., Wabash, Montpelier, O
Howson, A. W., asst. engr., I. C., Chicago
Kennedy, A. D., asst. engr.
Lindstrom, R. S., architect, Chicago.
Marquardsen, R. P. V., I. C., Chicago.
McDougall, N. R., C. & N. W. I., Chicago.
McNellis, Frank, asst. to secy., A. R. A., Chicago.
Schnatterbeck, C. C., American Wood Preservers' Association, Chicago.